# PROCEEDINGS

*FIFTEENTH ANNUAL MEETING*

# NORTH CENTRAL WEED CONTROL CONFERENCE

DECEMBER 3-4, 1958

CINCINNATI, OHIO

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*Proceedings*

# Fifteenth Annual Meeting

*of the*

# North Central Weed Control Conference

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## Announcement of 1959 Meeting

## Winnipeg, Manitoba, Canada

## December 9 & 10, 1959

## Headquarters—Royal Alexandra Hotel

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## *Preface*

The Proceedings of the 15th Annual Meeting of the North Central Weed Control Conference differs from previous Proceedings in several respects. As in the past it presents a record of the papers and reports presented at the 1958 Conference in Cincinnati, Ohio, December 3 and 4. However, this year, with the exception of the President's remarks and certain invitation papers, only abstracts of the papers given, limited to approximately 900 words, are presented here. Since essentially all of the papers are abstracts, none have been so marked.

This year for the first time, the Research Reports, which have previously been mimeographed and distributed at the Conference, have been printed and made a part of the Proceedings. The Summaries of each of the topics which have previously introduced the reports on each topic were this year extended to cover the research for the past decade and are published as a separate section, "Research Summaries," which follows immediately after the Proceedings.

Throughout this volume all rates of application of chemicals except inorganic soil sterilants are given in terms of the acid equivalent or active ingredient, so that no statement is made in connection with rates unless for some reason the rates cited are not of the acid equivalent or active ingredient.

Latin names of weeds and crops discussed and the full chemical names of herbicides for which standard names or abbreviations have been adopted by the Weed Society of America will be found in the indexes and such names have been omitted elsewhere in the Proceedings. Chemical names of new chemicals are given in each report of their use, and also in the index. No new products of which the chemical identity has not been released are discussed in this publication.

Copies of this Proceedings are available at $4.00 per copy from John D. Furrer, Secretary-Treasurer, North Central Weed Control Conference, Department of Agronomy, University of Nebraska, Lincoln, Nebraska.

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## PRESIDENT'S REMARKS

**Lyle A. Derscheid**[1]

Fellow members of the North Central Weed Control Conference and other friends; it is a real pleasure for me to have the opportunity to make a few remarks to you at this opening session of the fifteenth annual meeting of this Conference. I have really enjoyed the privilege of serving as your president this past year. I have enjoyed working with the members in planning this conference and I know I will enjoy the program today and tomorrow.

This is one organization in which there are no shirkers. Everyone is willing to do his share. As far as I know, there was not a single individual who declined, when he was asked or elected to perform certain functions. Our Conference has been growing for fourteen years and there are many such functions. It would be impossible for a president or even the executive committee to attend to all of them. Likewise, it would be impossible for a president to have a successful year without the cooperation of the committee chairmen and the members of the Board of Directors. If we have had any success this year, it is because all of the committees functioned superbly. They have made the office of president rather easy to fill. They are listed on the first page of the program. I wish to thank all of them.

I shall spend a few minutes to explain some new conference policies being inaugurated this year. As you know, we have previously had three conference publications. Papers presented on the program were printed in the Proceedings, which was distributed during the spring after the conference adjourned. Many authors submitted the entire paper for publication in the Proceedings and did not submit it to WEEDS. Abstracts of current research were mimeographed and assembled in the Research Report. However, there were complaints about its not fitting library shelves and there were complaints about its falling apart. In addition, the Research Committee developed a set of regional recommendations. These were mimeographed and distributed at the Conference. However, the Miller Bill curtailed the amount of information that could be placed in them and they had merely repeated themselves for about five years. Sometimes they were out of date before the spraying season arrived. Last year for example dalapon was not recommended for use in flax. Everyone knew it would work, but it had not been cleared by the Pure Food and Drug Administration. It was finally cleared in May and our flax recommendations were out of date.

We have had a Publications Committee studying these problems for three years. They have made a recommendation to the Board of Directors. After one or two amendments, a procedure was adopted. It is being put into effect this year.

There will be only one publication. It will be printed after the conference adjourns. It will include abstracts of the papers presented on the program, a summary of research, and abstracts of research. The abstracts of papers presented at the Conference will be limited in length to three double-spaced typewritten pages. They will be considered as asbtracts and the complete paper can be submitted to WEEDS for publication. The reports of research will be the same abstracts that were previously reported in the Research Report. However, they should not be used to report old findings, but rather to report findings that may lead to new developments. The Research Summaries replace the Recommendations. This will be mimeographed and distributed at the registration desk each year and will also be printed in the Proceedings. A comprehensive summary was written this year. In succeeding years this entire summary will not be reprinted. However, supplements, including new developments which will bring this year's summary up-to-date, will be prepared each year. It is anticipated that the entire summary will be revised every five or six years.

These changes were necessary for the administration of the organization, but what about the changes brought about by the Conference? What progress has been made in the field of weed control that can be attributed to this Conference and others like it?

In my opinion, these organizations have been highly instrumental in stimulating interest in the field of weed control; they have created a spirit of cooperation and coordination among all the agencies concerned with weed control, and they have made it possible to pool information on the subject.

In 1944, there were 90 Federal, State and County officials in the North Central states who were interested in weed control. Today we have over 500 dedicated weed fighters. We have botanists, horticulturists, agronomists, foresters, landscape architects, chemists, plant physiologists, plant ecologists, plant pathologists, engineers, and others. We have men interested in research, extension, law enforcement, industry, commercial spraying, and people interested in killing weeds on their own land as well as those engaged in supervising weed control programs. We have people representing Federal agencies. We have people representing State or Provincial agencies. We have people representing County or Municipal agencies. We have those representing chemical companies, those representing machinery companies and those representing public and private organizations that have weed problems.

We have had noxious weed laws in our states and provinces for many years. However, these laws killed very few weeds. It did very little good to decree that it was a misdemeanor to allow noxious weeds to flourish if no one knew how to control them. Likewise, a file cabinet of data which revealed how to control or eliminate the weeds was of little value, if they were not distributed to the man responsible for controlling the weeds.

File cabinets have been filling with weed control data for three-quarters of a century. Beal started his famous "buried seed experiment" in 1879. Selective weed control with chemicals was being studied at the turn of the century. Brenchley started to study the competitive effects of weeds before World War I and Briggs and Shantz determined transpiration ratios of several weed species about the same time. During the 1930's Pavlychenko and Harrington studied methods of controlling wild oats and other annual weeds by comparing their root systems, $CO_2$ assimilation areas and the ability of their seeds to germinate with similar characteristics of crops. At the same time, Bakke, Stahler, and Timmons learned how to control and eliminate field bindweed. There are many other examples of weed control data that were available. However, these are enough to illustrate that we had much information on how to control weeds long before there was any concerted effort to control them. No one apprised the farmer of the need for weed control, and no one taught him how to control them.

Everyone who knew anything about weeds knew that weeds had no respect for farm boundaries, county lines, or state or country borders. They also knew that an individual farmer had little chance of keeping his farm free of weeds if his neighbors allowed them to propagate abundantly. However, there was no one to coordinate their activities.

When research personnel, extension workers, regulatory men and others met in conference, they found the missing links. They agreed that a successful weed control program required several steps. There was a need to learn more about how to control weeds. It was necessary to teach the landowner why the weeds should be controlled. It was essential to establish weed control organizations. It was mandatory that information on methods of controlling the weeds be disseminated. There was a need for a good weed law and regulatory men to enforce the law on the few people who refused to control their weeds voluntarily.

Later the industrial people met with the research, extension and regulatory workers and the use of chemicals and new types of machinery were incorporated into the weed control program.

It would be foolhardy for me to state that there



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would not have been this coordination of activities if there had been no North Central Weed Control Conference. However, I think I can truthfully state that this Conference has been instrumental in hastening such coordination.

Since the purpose of this Conference, as stated in the Constitution, is to coordinate activities and to discuss and plan means of securing more adequate weed control, and since I have given it credit for achieving this purpose, someone might ask if it is necessary to continue the organization. I say "yes" because we are not finished. We have made progress, but we still have much coordination to do. We still have a need for pooling information. I believe that everyone in this audience will learn something today and tomorrow that will help him do a better job when he gets home.

Some might then raise the question about pooling information in a National or International organization, such as the Weed Society of America. They could add that most other groups have National organizations. I cannot deny that we can gain much by rubbing shoulders with people from other regions in the Weed Society of America, but I can point out that several National organizations have regional branches or conferences. I can also point out that the membership of most National organizations is composed largely of research workers with a sprinkling of people engaged in other activities. In weed control, we need extension workers, regulatory people, industrial workers as well as research men. Weed problems vary greatly from region to region and we can get more accomplished by working as a regional group. I am not trying to detract from the importance of the Weed Society of America, but wish to emphasize the importance of our North Central Weed Control Conference. I think that both organizations are important and merit our wholehearted support.

I believe that the North Central Weed Control Conference has a worthy purpose and I believe it is achieving that purpose. We have not yet reached the final goal and should keep plugging away.

[1] Department of Agronomy, South Dakota State College, Brookings: President, NCWCC.

At the close of President Derscheid's remarks, Chairman Foster introduced Dr. E. R. Hattingh of African Explosives and Chemical Industries Ltd., Johannesburg, Union of South Africa, who was in this country visiting weed control organizations and personnel. He gave an interesting talk, illustrated by colored slides, on weed problems and weed control in tropical countries.

## THE BIOLOGICAL ACTIVITY OF TETRAZOLE DERIVATIVES OF INDOLE-3-ACETIC AND 2,4-DICHLOROPHENOXYACETIC ACID

**R. H. Hamilton and A. Kivilaan**[1,2]

Few plant growth substances are known that do not require a carboxyl group (or group convertible to a carboxyl) for activity. The active compounds reported are 3-indolemethanesulfonic acid (3, 5), 1-naphthalenemethane-, 1-naphthalene-, and 3-indolesulfonic acids (3). In addition activity has also been reported with naphthalene and indole phosphonic and phosphonous acids (4).

Indole-3-methyltetrazole (IMT) and 2,4-dichlorophenoxymethyltetrazole (2,4-DMT) were tested for activity in an Avena section straight growth test (2) alone and in combination with either 2,4-D or IAA. In initial tests it appeared that 2,4-DMT was not competitive with IAA-induced growth but did compete with 2,4-D. Later extensive tests indicated (Tables 1 and 2) that this derivative may be considered to be essentially uncompetitive with either IAA or 2,4-D. That is, higher concentrations of either IAA or 2,4-D are not very effective in reversal of the inhibition. IMT was highly active at concentrations above $10^{-5}$ M (Tables 1 and 2). This derivative stimulated or depressed IAA-induced growth depending on whether the IAA concentration was low or high respectively. In the case of 2,4-D-induced growth all concentrations of IMT were stimulatory except with $2.25 \times 10^{-6}$ M 2,4-D. Thus IMT fits the classical picture of a weak "auxin" exceedingly well.

**Table 1. The percent change in IAA-induced elongation of Avena sections after 10 hours in presence of IMT or 2,4-DMT.**

| Tetrazole derivative moles/liter | Percent change in elongation of Avena sections induced by IAA (moles/liter x $10^7$) | | | | |
|---|---|---|---|---|---|
| | 0 | 1.4 | 2.8 | 5.7 | 28 |
| None | 1.12* | 2.15* | 2.54* | 2.03* | 3.05* |
| $10^{-5}$ IMT | +11.5 | +3.1 | +12.2 | +3.9 | —3.5 |
| $10^{-4}$ IMT | +119.0 | +21.2 | +8.5 | —7.5 | —21.5 |
| None | 1.55* | 2.70* | 3.55* | 3.87* | 4.27* |
| $10^{-5}$ 2,4-DMT | —25.8 | 0 | —7.6 | —10.7 | —1.7 |
| $10^{-4}$ 2,4-DMT | —51.6 | —34.3 | —35.3 | —30.0 | —26.1 |

* Elongation in mm

**Table 2. The percent change in 2,4-D induced elongation of Avena sections after 10 hours in presence of IMT or 2,4-DMT.**

| Tetrazole derivative moles/liter | Percent change in elongation of Avena sections induced by 2,4-D (moles/liter x $10^7$) | | | | |
|---|---|---|---|---|---|
| | 0 | 1.25 | 2.50 | 10.00 | 22.50 |
| None | 1.20* | 1.36* | 1.75* | 2.06* | 3.13* |
| $10^{-4}$ IMT | +12.5 | +13.4 | +11.6 | 0 | 0 |
| $10^{-4}$ IMT | +150.0 | +119.0 | +68.5 | +44.0 | —2.1 |
| None | 1.07* | 1.10* | 1.50* | 2.07* | 3.25* |
| $10^{-3}$ 2,4-DMT | —32.5 | —22.7 | —26.5 | —29.5 | —15.4 |
| $10^{-4}$ 2,4-DMT | —67.3 | —68.2 | —71.4 | —70.5 | —50.7 |

* Elongation in mm

It is apparent that the tetrazole ring may substitute for the carboxyl group at least in the case of the indole derivative. Thus it is apparent that site of action is not specific in regard to the acidic group. A ring is also not necessary since certain thiocarbamate derivatives are active (1). Herbicidal screening tests indicated these derivatives have little activity at 5 pounds per acre pre- and post-emergence on several crop and weed species.

Literature Cited

1. Kerk, G. J. M. van der, Roalte, M. H. van, Kaars, Sijpesteijn A., and Veen, R. van der. A new type of plant growth-regulating substances. Nature 176: 308. 1955.
2. McRae, D. H., Foster, R. J. and Bonner, J. Kinetics of auxin interaction. Plant Physiol. 28:343-355. 1953.
3. Veldstra, H. The relation of chemical structure to biological activity in plant growth substances. Ann. Rev. Plant Physiol. 4:151-198. 1953.
4. Veldstra, H. On the form and function of plant growth substances. p. 117-133. The Chemistry and Mode of Action of Plant Growth Substances. Editors: Wain, R. L., and Wrightman, F. Academic Press Inc. New York, New York, 1956.
5. Vlitos, A. J., and Hitchock, T. S. Plant growth regulating activity of 3-indole-methanesulfonic acid. Contrib. Boyce Thompson Inst. 19:255-265. 1958.

[1] United States Department of Agriculture, Agricultural Research Service, Crops Research Division, and Michigan Agricultural Experiment Station, East Lansing, Michigan.

[2] The tetrazole derivatives were synthesized and made available through the courtesy of Dr. James McManus and Professor R. M. Herbst, Department of Chemistry, Michigan State University.



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## STUDIES CONCERNING THE FATE OF LONG-CHAIN ESTERS OF 2,4-D IN PLANTS

**D. J. Morre and B. J. Rogers** [1]

Many esters of biologically important acids have been used as a means of ensuring penetration into plant tissues. Since much of the 2,4-D sold is in the form of alcohol esters, a study of the metabolism of 2,4-D esters was initiated.

In order to determine if the inherent toxicity of the 2,4-D molecule was changed by esterification, a standard dose-response curve for corn root inhibition was examined. All studies involving root inhibition were performed at 24° C. and pH 7. The corn seedlings were germinated 48 hours and grown on filter paper in the solutions to be tested. Humidity was kept at approximately 100%.

It has been proposed that if two toxicants are acting through the same pathway, the transformed dose-response curves will exhibit the same slope. When the dosage was plotted on the horizontal axis and root growth as percent of control in terms of probits on the vertical axis, a straight line was established for both the acid and the ester. Since the slopes were very nearly equal for both the acid and the ester, it was assumed that the inherent toxicity had not been greatly changed by the addition of an alcohol through an ester linkage.

The transformed dose-response curve can be further characterized by position as well as slope. The position is usually designated as the dosage required to affect a given portion of the population. In the case of corn roots less 2,4-D and not less ester, as might be expected on the basis of leaf applications, was required at the ED 50. This could be due to differential uptake by roots. Studies with $C^{14}$ labeled 2,4-D and octyl ester did show such a penetration difference. The ester was apparently taken up more slowly than the acid.

Alcohols, in general, are classified as narcotics and there exists the possibility of a growth effect resulting from the alcohol moiety of the ester molecule. A plot of percent inhibition of corn root growth for a 24-hour period vs. time of germination did show a deviation from the expected response at the 72 and 96-hour germination times. This deviation could be traced to a stimulation of growth corresponding to low concentrations to octyl alcohol.

The studies on penetration and mode of action also afforded a means of assaying 2,4-D acid in the presence of an ester. Cucumber seedlings germinated for 54 hours appeared to be the most satisfactory as a bioassay. Of the long chain esters studied, only the octyl ester provided differences sufficient to permit quantitative interpretation. During a 12-hour growth period the octyl ester had little or no effect over a four-fold concentration range whereas root growth was proportional to the same concentrations of 2,4-D acid.

Using the cucumber root inhibition test, enzyme-catalyzed hydrolysis of the octyl ester was demonstrated for cell-free preparations of corn roots, corn cotyledons, corn embryos, cucumber roots, cucumber cotyledons, pumpkin seeds, and spinach leaves. Of these, cucumber cotyledons, pumpkin seeds, and an acetone powder prepared from spinach exhibited the highest enzyme activity.

When crude protein obtained from cucumber cotyledons was added to a buffered solution containing 0.5 to 2 mg. of 2,4-D acid per liter as the octyl ester, root inhibition which corresponded to 100% conversion of the ester to the acid was observed. This effect was not due to a non-specific protein effect, since tests with boiled protein or powdered egg albumin did not result in inhibition.

Although the hydrolytic activity of these tissues with respect to esters of 2,4-D was too low to be measured by the standard laboratory methods for the determination of esterases, it is felt that the activity of the cell-free preparations was more than sufficient to account for the observed response in intact roots.

Further evidence for conversion of the ester to the acid was obtained from the bean epicotyl bending test. Seedling kidney bean plants were treated with 5 ug of 2,4-D on one primary leaf. Curvature was initiated in acid-treated plants about 2 hours after treatment. A lag of 1-1½ hours was observed from the octyl ester and the curvature from the ester-treated plants was somewhat less than that resulting from the acid. Since both the acid and the ester response were proportional to light intensity, these data are indicative of hydrolysis of the ester prior to translocation.

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## EFFECT OF 2,4-D TREATMENT ON THE RESPIRATORY METABOLISM OF ETIOLATED SOYBEAN SEEDLINGS

**J. L. Key and J. B. Hanson** [1]

Switzer [2] has found that 2,4-D inhibits the oxidative and phosphorylative activity of mitochondria isolated from etiolated soybean seedlings. However, when the soybean seedlings were sprayed with $5 \times 10^{-4}$ M 2,4-D 18 to 24 hours prior to isolation of mitochondria, these mitochondria possessed a greater oxidative and phosphorylative activity than did corresponding control mitochondria. He concluded that the 2,4-D treatment had resulted in formative effects of the chemical which permitted isolation of particles which retained more of their original activities.

The experiments reported here confirm and extend Switzer's findings. Mitochondria isolated from soybean seedlings sprayed with 110 ppm 2,4-D (15 ml/8.5 x 13-inch baking dish) do have higher oxidative and phosphorylative activity than the control mitochondria, phosphorus uptake being stimulated much more than oxygen uptake. These data were confirmed with tissue studies where oxygen uptake and phosphate uptake were measured simultaneously. Using the efficiency of phosphate uptake (uM $PO_4$ absorbed/uA $O_2$ uptake/hour) as a measure of internal coupled phosphorylation, the data showed that mitochondria of the swollen hypocotyl and root tissues were more tightly "coupled" than mitochondria of the control tissue while the apical section of the hypocotyl showed the inverse effect.

The mitochondria from 2,4-D sprayed tissue contained more soluble nucleotide per unit mitochondrial nitrogen than did the control mitochondria and showed no requirement for added adenylate acceptor for maximum respiration while control mitochondria showed requirement for added adenylate acceptor. The 2,4-D mitochondria had a significantly higher phospholipid content than the control mitochondria. The RNA content was so variable owing to microsomal contamination that no significant difference in RNA content was obtained, but the data suggest that the 2,4-D mitochondria possess a higher content of "functional" RNA.

The data suggest that 2,4-D has produced changes in the mitochondria of the swollen hypocotyl similar to those accompanying normal auxin induced growth except that the 2,4-D spray treatment has produced a pronounced morphological change in the mitochondria. Electron micrographs of both in situ and isolated mitochondria reveal that the mitochondria of the swollen 2,4-D tissue are larger, more round than ellipsoid, and more membraneous with less detailed structure than



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control mitochondria, while mitochondria of the apical section are not detectably different in these characteristics.

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[2] Switzer, C. M. Effects of herbicides and related chemicals on oxidation and phosphorylation by isolated soybean mitochondria. Plant Physiology 32:42-44. 1957.

## A PROGRESS REPORT ON THE PHYSIOLOGY OF SIMAZIN IN THE CORN PLANT

**Edwin O. Schneider** [1]

Simazin was introduced in the United States for herbicidal evaluation by experiment station and other workers in 1956. Tests in 1956 and again in 1957 demonstrated the efficiency of the product as a selective herbicide in corn as in other agronomic and horticultural crops for the control of most annual broadleaf weeds and grasses. Besides the selectivity to corn, simazin also is tolerated by asparagus, grapes, pineapples, sugar cane, brambles and many other woody species of plants. Many workers have been studying the uptake and mode of action of simazin by corn and other plants.

When applied as a pre-emergence herbicide to the soil, simazin is taken up by the roots of plants, both crops and weeds. If a sensitive plant such as wheat is grown in simazin-treated soil, it can be shown by proper analytical methods that only a small part of the total amount of simazin applied to the soil is picked up by the roots. When, however, wheat seedlings are kept in nutrient solutions containing several parts per million of simazin, about 5 ppm, calculated on the fresh weight of the plant, can be found. If the same experiment is repeated with corn seedlings grown in nutrient solutions, the amount of simazin found is 0.2 ppm or lower. In corn seedlings grown in simazin-treated soil, none of the chemical could be found in the plants when an analytical method sensitive to 0.1 ppm was used.

In studies with radioactive simazin, it was shown that the compound is taken up in about the same amount by cucumbers, cotton, and corn, representatives of very sensitive, medium sensitive, and tolerant plants. This indicates the simazin must be metabolized in the corn plant.

Plants affected by simazin show the same chlorosis pattern as the urea herbicides. It has been found that both the urea and triazine herbicides inhibit the Hill reaction or the ability of the chloroplasts to break down water to hydrogen and oxygen in the presence of light and iron. Simazin gives a 50% inhibition of the Hill reaction in concentrations of $7 \times 10^{-7}$M, whereas monuron requires $8 \times 10^{-7}$M. Other herbicides such as 2,4-D, amitrol or maleis hydrazide do not cause any significant inhibition at concentrations as high as $10^{-4}$M.

The relative ease of the hydrolysis of the chlorine atom in simazin by dilute mineral acids indicates that "hydroxy-simazin" is the first metabolite in corn.

Freed[2] found that corn seedlings grown in a soil treated with radioactive simazin produce radioactive $CO_2$. This was confirmed later by McCollum and Ragab. These findings indicate that the triazine ring is completely broken down. The remaining fragments of the molecule are not stable and are metabolized to simple compounds which are used by the plant.

A uniform distribution of the radioactivity throughout all tissues of corn plants is shown in radioautograms of plants treated with radioactive simazin. This indicates that the decomposition products of simazin are used by the plant.

It was found recently that a polyphenol fraction isolated from corn is able to metabolize simazin in vitro. Phenols from other simazin-resistant plants like millet or *Imperata cylindrica* break simazin down only when horse-radish peroxidase is added, thus indicating that different resistant plants have different mechanisms to neutralize the phytotoxicity of simazin.

[1] Geigy Agricultural Chemicals.

[2] Freed, V. H. Oregon State Univ., Corvallis, unpublished work.

## PHYSIOLOGICAL RESPONSES OF CORN ROOTS TO DALAPON

**M. Ingle and B. J. Rogers**[1]

The primary roots of corn are being employed as a model system to investigate the physiological and biochemical effects of 2,2-dichloropropionic acid (dalapon) on higher green plants. The aim of these studies is to gain some insight into the herbicidal mechanism of action of this compound. Growth in length has been used as the assay for the activity of the compound under varying conditions.

Dalapon is inhibitory to corn roots in the concentration range of $10^{-2}$ to $10^{-3}$ M. Fifty percent inhibition occurs at about $3 \times 10^{-3}$ M. Frequently slight stimulations, amounting to 15%, have been observed at $6 \times 10^{-4}$ M. These stimulations are generally not statistically significant.

The pH of the ambient solutions has a pronounced effect on the response of corn roots to a given concentration of dalapon. The table shows variations in growth at different hydrogen-ion concentrations. Such a response should be anticipated because of the strongly

| pH | Length increases—percent of control | |
|---|---|---|
| | Dalapon concentration | |
| | $5 \times 10^{-3}$M | $9 \times 10^{-3}$M |
| 7 | 56 | 42 |
| 6 | 53 | 32 |
| 5 | 30 | 22 |
| 4 | 25 | 17 |
| 3 | 21 | 1 |

acidic nature of dalapon. The pH response, typical of many growth regulators and metabolic inhibitors, probably reflects enhanced penetration of the undissociated molecule as compared to the ion. Since both concentration and pH strongly influence the activity of dalapon, these variables must be specified in the description of any response in a system such as this.

An inhibitory quantity of dalapon is able to enter corn roots and exert its effect in a relatively short time. Seedlings were transferred to dalapon-free solutions after varying periods in the inhibitor and the total change in length determined after 24 hours. Significant inhibition occurred in those seedlings which had been in dalapon for four hours. Those seedlings which were in dalapon eight hours showed the same root growth inhibition as those whoch had been in dalapon for the entire 24 hours. Growth-rate measurements over a 24 hour period again showed that the maximum inhibition percentage-wise was established in twelve hours. Total growth of untreated roots was nearly linear over 24 hours; dalapon-treated roots reached a plateau in about twelve hours.

Hilton[2] has reported that growth inhibitions in yeast and *E. coli* produced by dalapon could be reversed noncompetitively with B-alanine and competitively with pantoic acid. Working with the isolated B-alanine-pantoate condensing enzyme from *E. coli*, it was demonstrated that dalapon specifically blocked the incorporation of pantoate into pantothenate, a constituent of the metabolically important Coenzyme A. Attempts to reverse dalapon-induced corn root inhibition with B-alanine and pantothenate have been successful. More information is needed about the occurrence and activity of Co-A in this tissue before these data can be correlated with



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those of Hilton. At high concentrations ($10^{-2}$ M), pantothenate and B-alanine both cause inhibition; therefore, it seems unlikely that lack of reversal can be attributed to failure of penetration.

During a period in which there is pronounced growth inhibition there is no apparent effect on oxygen uptake. Corn roots show a linear oxygen uptake for at least six hours. This pattern is not modified by the addition of $7 \times 10^{-3}$ dalapon at pH 4. In a similar period of time there is a growth inhibition of 50%. Measurement of oxygen uptake by roots pre-treated with dalapon for 12-24 hours likewise failed to show depressions.

The effect of dalapon on another endergonic process, phosphate ion uptake, has been examined. Roots pretreated with $5 \times 10^{-3}$ dalapon and $1 \times 10^{-4}$ 2,4-dinitrophenol (concentrations which produce comparable inhibitions) were placed in aerated phosphated solutions containing $P^{32}$ for three hours. The specific activity of control, dalapon-, and DNP-treated roots were 7050, 3860, and 4720, respectively. It, therefore, appears that dalapon is able to inhibit processes which require metabolic energy normally represented by oxygen uptake.

[1] Purdue University, Lafayette, Indiana.

[2] Hilton, J. L. Inhibition of pantothenate synthesis by chloro-substituted aliphatic acids. Plant Physiol. 33 (Suppl.) XLVI.

## ABSORPTION AND TRANSLOCATION OF AMITROL IN CORN AND SOYBEAN PLANTS

**D. D. Bondarenko[1]**

On June 13, 1957 corn was planted in a cultivated Brookston-Miami complex silty clay loam topsoil contained in one of three 2-bushel aluminum baskets in the field. The baskets were set in holes so that three-fourths of each basket was below ground level. On June 25 the corn, which was at the 3 to 4-leaf stage, was treated with $C^{14}$-amitrol (specific activity, 1.10 mc/mM) plus amitrol at 0.5 + 0.5 lb/A in 100 gallons of water. In one of the other baskets $C^{14}$-amitrol (specific activity, 1.10 mc/mM) plus amitrol at 0.8 + 7.2 lb/A in 100 gallons of water were applied to the soil on June 13. On June 20 the soil was thoroughly mixed to a depth of six inches and planted immediately to soybeans. Non-treated corn and soybean plants in the third basket served as checks.

Analyses for labeled material in the corn and soybean plants were made by autoradiography. Autograms were made of three to six corn and soybean plants harvested on July 3, 16, and 30, and of corn seed, ear silk and husks and soybean seed and pods harvested at maturity on October 20. The leaves of the corn plants were removed, dried in a herbarium press, and glued to sheets of paper in the same relative positions as they were on the plant. The soybean plants were dried and mounted whole or in large sections. The corn and soybean seeds were cut in half and mounted so that the insides were exposed to the X-ray film. Ansco non-screen X-ray film was exposed to the dry plant mounts for 45 days and then developed, fixed, and dried.

The treated corn plants that were harvested on July 3, 16 and 30 contained large amounts of labeled material in all parts of the plants. The labeled material was more concentrated in the veins of the leaves than in the interveinal tissue. The labeled material was distributed the same in the amitrol induced chlorotic tissue and the green plant tissue. The corn seed, ear silk and husks contained small amounts of labeled material. The corn checks contained no labeled material or only extremely small amounts.

In the treated soybean plants, labeled material was uniformly distributed in small amounts throughout all parts of the plants harvested on July 3, 16 and 30, and in smaller amounts in the seeds and pods harvested on October 20. The soybean checks contained no labeled material or only extremely small amounts.

[1] The Ohio Agricultural Experiment Station and The Ohio State University, Columbus 10, Ohio.

## DECOMPOSITION OF AMITROL IN SOIL

**D. D. Bondarenko[1]**

The effect of amitrol on the general microbial activity in Brookston silty clay loam (pH 6.7, 6.8% organic matter) and Miami silt loam (pH 5.8, 4.1% organic matter) virgin topsoils in the laboratory was measured by the amount of carbon dioxide evolved from treated and non-treated samples of these soils. One hundred gram air-dry samples of each soil were passed through a two mm sieve and placed in 250-ml Erlenmeyer flasks. Quadruplicate samples of the Brookston and Miami soils were treated with amitrol at 10 and 6 lb/A, respectively, in sufficient water to bring each soil to approximate field capacity. Four samples of each soil supplied with water only served as treatment checks. Immediately after treatment the flasks were connected to an aspiration apparatus arranged to pass a constant stream of carbon dioxide-free air at 100 per cent humidity over the surface of the soil. The temperature was maintained at 28°C. throughout the 28 day incubation period. The evolved carbon dioxide was collected in 1N NaOH and measured volumetrically by precipitation as $BaCO_3$ with 3N $BaCl_2$ and titration of the excess base with standard HCl.

Differences in the daily and total carbon dioxide evolved from the amitrol treated Brookston and Miami soils and the corresponding checks of each soil were non-significant during the 28 days of incubation.

Another experiment similar to the one mentioned above was conducted to measure amitrol decomposition in Brookston silty clay loam and Miami silt loam virgin topsoils in the laboratory. The treatments were similar to those in the above experiment except that $C^{14}$-amitrol plus amitrol were applied in the second experiment. The Brookston and Miami air-dry soil samples were treated with $C^{14}$-amitrol plus amitrol at 5 + 5 and 3 + 3 lb/A, respectively, in sufficient water to bring each soil to approximately field capacity. The evolved carbon dioxide was collected in NaOH, precipitated as barium carbonate, filtered, finely ground in ethanol and then plated for counting with a Geiger-Muller-Nuclear scaler. Corrections were made for background, self absorption, geometry, coincidence and the daily efficiency of the counting apparatus in this and the following experiment.

Considerable $C^{14}O_2$ was evolved from each soil within 24 hours after treatment, the first collection date. The rate of $C^{14}O_2$ evolution increased until the 13th day when the maximum rate was reached. Then the rate of evolution decreased rapidly until the 42nd day, then gradually until the experiment was terminated on the 240th day when extremely small amounts of $C^{14}O_2$ were evolved. The soil samples were stored at room temperature until the 18th month after treatment. Then the radioactivity in the air-dry soils was measured by placing 2.5 g. of the soil in each flask in counting planchets and counting with a Geiger-Muller-Nuclear scaler. Both treated soils contained rather large amounts of labeled material. The Miami soil contained 56% as much labeled material as the Brookston.

In the field experiment reported in the preceding abstract, samples of soil were taken 14 months after treatment at depths of 1, 3, 6 and 12 (bottom of basket) inches in each of the baskets. The soil was air-dried and then counted by a Geiger-Muller-Nuclear scaler.



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Small amounts of labeled material were present in both treated soils at the 1-inch level, none at the lower levels, compard with the check.

[1] The Ohio Agricultural Experiment Station and The Ohio State University, Columbus 10, Ohio.

## THE EFFECT OF AMINO TRIAZOLE ON CELL-FREE PREPARATIONS OF PLANT CATALASE IN RELATION TO HERBICIDAL ACTION

**E. Schweizer and B. J. Rogers[1]**

At the present time considerable information has been accumulated on the action of 3-amino-1,2,4-triazole (amitrol). It may be possible to correlate some of this information. We have observed that in corn, and in certain other plants, we can produce chlorosis from both high and low concentrations of amitrol. The high level dose produces chlorosis in tissue which is already green; this we prefer to call a contact-type injury. It is known that amitrol at these high concentrations can act as a protein precipitant, which would account for the observed chlorosis. At low concentrations (0.001 M) there is a systemic-type chlorosis which appears only in tissue in which chlorophyll has not yet become evident. Since work at Purdue, Chicago, and Texas A & M suggests that synthesis of the chlorophyll molecule is not inhibited by amitrol, we have ascribed this chlorosis to a disruption in the development of chloroplasts. We have shown this in corn and mustard leaves; investigators at UCLA have shown the same thing in barley and potato leaves. The amitrol-induced chlorosis in pine needles appears to be a special case; workers at Minnesota have found intact plastids in chlorotic needles. Although this phenomenon of chlorosis is interesting, we think that it is a side effect; in tissue culture experiments we have shown a severe growth inhibition in non-chlorophyll-containing tissue at physiological concentrations of amitrol.

The second point which may be considered concerns the importance of the observation that amitrol inhibits the action of catalase, an enzyme which catalyzes the decomposition of hydrogen peroxide. This inhibition has been studied most diligently by workers at UCLA and the Argonne Laboratories. It is a reaction which is easily illustrated; we used a partially purified preparation from spinach. It is possible that this particular inhibition is of primary importance in the herbicidal action of amitrol. If we examine a series of compounds related to amitrol, we find some correlation between catalase inhibition and herbicidal effectiveness. This connection is amenable to investigation; such compounds as sodium azide and potassium cyanide, which are effective inhibitors of catalase at concentrations one to two orders of magnitude lower than amitrol, would seem to be good possibilities. Streptomycin might also be studied; it inhibits catalase, and causes chlorosis as well.

With information from this cell-free test with catalase, we can speculate as to the necessary configuration for this type of herbicidal activity without being hindered by problems of permeability and transport. We can see that, with the possible exception of the compound 5-methyl-7-hydroxy-pyrimidotriazole, an active molecule must have (1) a free amino group, and (2) a triazole nucleus. Further, substitution on the number 5 carbon is detrimental. It would be interesting to study 3-amino derivatives of pyrrole and imidazole, their sulfur and oxygen analogs, and various heterocyclic combinations.

[1] Purdue University, Lafayette, Indiana.

## CONTROLLING SPRING WEED GROWTH IN TAXUS BY FALL APPLICATIONS OF HERBICIDES

**L. C. Chadwick[1, 2]**

One of the major problems in the control of weeds in commercial nurseries is the suppression or elimination of weed growth early in the spring. Cultivation is often difficult to accomplish during this season owing to unfavorable soil conditions or because nurserymen are busy digging, shipping or planting stock at that time. This experiment was conducted to determine the effectiveness of some herbicides applied during the fall on the elimination or suppression of weeds the following spring. If herbicides could be applied in the fall and suppress or eliminate weed growth during the months of March, April, and May, it would be a great aid to the nurseryman.

Five herbicides or combinations of herbicides, simazin, NPA (Alanap 20G), a combination of sesone and monuron, a combination of sesone and CIPC,, and CIPC were applied on November 1, 1957, to 150-square-foot plots in a block of *Taxus cuspidata intermedia*. Control plots were included and all treatments were replicated 10 times. Buffer strips, 2 feet wide, were left between each treatment. The soil was mostly a Brookston silt loam and was moist when the herbicides were applied. The herbicides were applied with a knapsack sprayer. The simazin was applied at two rates, 2 and 4 pounds per acre, CIPC at 8 pounds per acre, and Alanap 20G at 5 pounds per acre. The combination treatments, sesone and monuron were applied at 3.6 lb/A and 0.4 lb./A and sesone and CIPC were applied at 3.6 lb/A and 4 lb/A respectively. Check and treated areas were free from weeds at the time the applications were made.

Ratings of weed growth were made for each plot on May 12 and on June 26, 1958, based on actual weed counts and observation of weed coverage compared to the control plots and the adjoining buffer strips. Control plots were given a rating of 10 and the other plots rated from 10 to 0 depending on the prevalence of weeds in that particular plot. Weeds most prevalent in the area included purslane, crabgrass, chickweed, and pigweed. Quackgrass, bindweed, and Canada thistle were prevalent in certain areas.

The data in Table 1 show the average rating of weed prevalence in the 19 replicated plots. Ratings do not include quackgrass, bindweed, and Canada thistle. These three noxious weeds were eliminated from the ratings because they were unevenly distributed throughout the area or absent entirely from certain areas.

**Table 1. Average rating of weed prevalence in control and treated plots on May 12 and June 26, 1958.**

| Treatment | Rating 5/12/58 | Rating 6/26/58 |
|---|---|---|
| Control | 10.0 | 10.0 |
| Simazin 4 lb/A | 1.3 | 2.6 |
| Simazin 2 lb/A | 2.0 | 4.2 |
| CIPC 8 lb/A | 4.4 | 7.9 |
| Sesone 3.6 lb/A and CIPC 4 lb/A | 5.0 | 7.6 |
| Sesone 3.6 lb/A and monuron 0.4 lb/A | 5.4 | 7.6 |
| Alanap 20G 5 lb/A | 8.5 | 9.1 |

Simazin at both rates gave excellent weed control even after nearly eight months from the time of application. Chloro-IPC and the combination of sesone and CIPC, and sesone and Karmex W gave satisfactory weed control through May 12, but weed growth was prevalent in plots treated with these herbicides on June 26. Alanap 20G was generally unsatisfactory at the rate and under the conditions it was used.

In plots where quackgrass, bindweed and thistle were present, simazin (4 lb/A) stunted growth of bindweed and thistle slightly, but quackgrass was stunted con-



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siderably and off-color. Simazin (2 lb/A) gave similar results, but not as striking. Applications of sesone and monuron resulted in some stunting of quackgrass but had little effect on the growth of bindweed and thistle. Applications of sesone and CIPC resulted in a slight stunting of quackgrass but no effect on bindweed or thistle. Applications of CIPC alone resulted in little or no effect on the growth of quackgrass, bindweed, or Canada thistle.

In conclusion, one the basis of this experiment, it would appear that simazin applied in the fall at 2 or 4 pounds per acre would result in greatly suppressing or eliminating weed growth the following spring and early summer without injury to *Taxus*.

[1] Department of Horticulture, Ohio Agricultural Experiment Station, Columbus, Ohio.

[2] Approved by Dr. W. E. Krauss, Associate Director, Ohio Agricultural Experiment Station.

## COMPARATIVE COSTS OF WEEDING TAXUS PLANT BEDS [1]

**J. W. Herron[2]**

Since controlling weeds in nursery plant beds is an expensive item in the production cost of nursery stock, a study was made to compare the costs of chemical weed control with the costs of hand weeding in beds of *Taxus Hicksi*. The study was made in a commercial nursery. One individual taken from the regular labor crew made the chemical applications and did the hand weeding for the entire study.

Two *Taxus Hicksi* plant beds, each containing 640 sq. ft., were chosen. On one bed applications of sesone at the rate of 2.7 lb/A of active ingredient were made. The other bed received no chemical treatment. Chemical treatments were applied on June 27, July 20, August 20 and September 20. Each bed was hand weeded before each application. The applications were made with a garden-type hand sprayer.

The cost of herbicide per bed was 11 cents for each treatment. Labor costs were based on the rate of $1.00 per hour.

In this study the time required to hand weed the chemically treated bed for a period of 3 months was approximately 43 percent les than the time required to hand weed the untreated bed. The total cost (including the cost of the herbicide) of weed control on the chemically treated bed was 33 percent less than on the untreated bed.

1. Published with the approval of the Director of the Kentucky Agricultural Experiment Station.
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## THE EVALUATION OF HERBICIDES FOR SEVERAL SPECIES OF ORNAMENTALS

**S. K. Ries, B. H. Grigsby, and H. Davidson[1]**

In a screening test on lining out stock, fourteen different treatments including nine chemicals were applied to four species of woody ornamentals. The best herbicide tested was simazin applied three days after transplanting, at 2 and 4 pounds per acre. This material effectively controlled weeds for the entire 1957 growing season and the spring of 1958 without causing any injury to the four species tested.

Although the four species responded similarly to all chemicals, there was a variation in their tolerance to the toxic materials. The difference in susceptibility between the two species of Taxus was outstanding.

Further application in 1958 of four pounds per acre of simazin on those receiving that amount in 1957, did not result in injury to any of the four species.

In a fall test comparing fumigants with simazin, all treatments resulted in excellent weed control the following spring. There was no injury to any species from SMDC (Vapam), DMTT (Mylone), or methyl bromide (MC-2). Simazin caused severe injury to forsythia, pyracantha and euonymus. Juniper and tulips were not injured by simazin.

In greenhouse studies with simazin, its derivatives and dalapon, it was found that of the species studied, simazin only caused injury to euonymus. Pachysandra and Taxus were injured by dalapon. The combination of simazin with dalapon injured all species with the exception of juniper, indicating that there may have been a synergistic effect in mixing the two.

In a study involving rates of simazin, temperature, species, and soil type, it was found that only baltic ivy was injured at the low 60° F. temperature regardless of the soil type.

More injury from simazin occurred on the sandy loam than either clay loam or muck soils. Hemerocallis and juniper were resistant to simazin at eight pounds per acre regardless of environment.

Both euonymus and baltic ivy were severely injured or killed by the eight pounds per acre rate of simazin applied to the sandy loam under a 70° F. night temperature.

In a test in cooperation with nursery growers, simazin at two pounds per acre was compared with four pounds per acre of neburon, sesone, and a non-toxic material. The growers only knew the materials by a code letter. No injury to nursery stock was reported from any material. Of the eight growers who returned reports, seven reported simazin better than, and one as equal to, sesone and neburon. Weed control held up for a longer period with simazin than with either neburon or sesone.

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## HERBICIDAL PROPERTIES OF NEBURON

**D. E. Wolf, R. S. Johnson, G. D. Hill and R. W. Varner[1]**

The successful use of a chemical for weed control in crops depends upon certain basic requirements. These include (a) consistent control of weeds under practical use conditions, (b) a wide margin of safety to the economic plants, and (c) a favorable rate of disappearance from soil that permits the normal growth of subsequent crops.

In addition to the research conducted at our laboratories and field stations, neburon has been evaluated widely by public investigators. Promising results have been obtained for control of weeds in perennial ornamentals, tomatoes, strawberries, and beans (lima, green snap, and dry). Utility has been demonstrated on other horticultural crops—spinach, onions, carrots, peas. celery, potatoes, peppers, craneberries, gladiolus, and sweet pea. Successful agronomic uses include control of annual weeds in newly seeded alfalfa, elimination of chickweed from established forage plantings as well as turf, and the control of wild and tartary buckwheat in small grains. At the present time, recommendation of this product for commercial use is limited to certain ornamentals.

**Physico-chemical characteristics.** Differences in solubility characteristics and soil adsorption give the family of substituted urea herbicides (monuron, diuron, fenuron, and neburon) great versatility for weed control. The low solubility of neburon in water (5 ppm) coupled



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with a high soil adsorption coefficient hinder downward movement in soil. This gives neburon a preferred position for chemical weed control in sensitive crops.

**Control of weeds.** Weed control efficiency with neburon is correlated with soil type. With adequate moisture present, 2 lb/A gives good control of annual weeds on sand or sandy loam soils. Four pounds per acre is required for 6 to 8 weeks control on clay loams. On some organic soils (muck) 6 to 8 lb/A is required.

Due to the low water solubility of neburon, weed control is more dependent upon moisture than with monuron or diuron. In general, weed control under field conditions has been satisfactory when 0.75 to 1.5 inches of rainfall was received within a period of two weeks after application.

**Safety to crops.** Neburon is equally safe to crops over a variety of mineral soils. Either pre-or post-emergence sprays of wettable powders have been effective depending upon the crop and method of culture. Overall post-emergence sprays have been used successfully on some crops, including tomatoes, strawberries, and perennial ornamentals. Limited studies with granular neburon have shown that this type of formulation has outstanding promise on a variety of crops. A greater margin of safety to foliage and better weed control due to more efficient use of the herbicide were noted.

In a silt loam soil, alfalfa and carrots planted at a ¼-inch depth grew normally following pre-emergence applications of 4 and 8 pounds, respectively. Millet, ryegrass, mustard, and pigweed were killed at 4 lb/A.

**Disappearance from soil.** The rate of disappearance of neburon from a wide variety of soils at several locations was measured under field conditions over a three year period. Results from chemical analyses and growth of indicator crops show that when neburon is used annually for weed control in crops at rates of 4 to 6 lb/A, phytotoxic concentrations disappear from the soil within 5 to 10 months after treatment. Representative locations included Santa Maria, Calif.; Raleigh, N. C.; Palma Sola, Fla.; and Newark, Delaware.

**Woody ornamentals.** Neburon has been evaluated from one to four years on established woody ornamental plantings in 15 states. This material is registered for use as "Kloben" Neburon Weed Killer (wettable powder—50% active) for control of annual broadleaf and grass weeds in commercial plantings of certain woody ornamentals.

No significant injury to 40 ornamental species has been noted after three successive annual treatments each of 16 lb/A in Delaware, North Carolina, and Florida. Good weed control was obtained at all locations with 4 lb/A.

**Tomatoes.** Neburon has exhibited an outstanding degree of safety on tomatoes in tests at widely separated locations during the past three years. With post-emergence overall treatments, only a slight degree of temporary stunting was noted with rates up to 6 lb/A. Excellent weed control was obtained with 2 to 4 lb/A where adequate water was received during the 14-day period after treatment.

**Strawberries.** Successful weed control in strawberry plantings with neburon has been demonstrated in a number of geographical areas at rates of 2 to 4 lb/A. The lower rate is adequate for fall or winter applications directed toward the control of chickweed. Spring treatments over existing strawberry foliage have given extended control of a variety of weeds at rates of 3 to 4 lb/A.

**Other crops:** Studies in the United States and Europe have resuletd in favorable data with neburon at rates of 3 or 4 lb/A for pre-emergence weed control in lima, green snap, and dry beans.

Preliminary experience in many parts of this country has indicated that neburon may aid the establishment of forage legume stands without the use of a cereal nurse crop. Beneficial results following the use of neburon on seedling stands have been demonstrated for both alfalfa and trefoil.

Annual and perennial chickweeds are among the few established plants that are killed by neburon at low rates. Post-emergence application of 2 lb/A in the fall or early spring has provided excellent kill without injury to common turf grasses and most perennial forage crops.

Investigators working in the Great Plains area of the United States and Canada have shown that post-emergence applications of neburon (2 lb/A) will kill wild and tartary buckwheat without serious injury to cereal crops.

[1] Grasselli Chemicals Dept., Experimental Station, E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.

## POSSIBLE USES OF 2.5-DICHLORO-3-NITRO-BENZOIC ACID FOR WEED CONTROL IN HORTICULTURAL CROPS

**G. F. Warren[1]**

The chemical 2,5-dichloro-3-nitrobenzoic acid was applied as the sodium salt to 29 species of plants growing in the greenhouse. The plants represented included several vegetable crops, strawberries, and eight annual weeds. Both pre- and post-emergence sprays were applied. Pre-emergence treatments at rates of 2 and 4 pounds per acre gave excellent control of all the weed species tested. The following crops showed little or no injury: asparagus seedlings, carrots, parsnips, lettuce, strawberries, sweet potatoes and all varieties of pumpkins and squashes tried. In general selectivity was similar when post-emergence applications were made but the activity was lower. The exception was with pumpkins and squashes which showed good resistance to pre-emergence treatment but were severely damaged by post-emergence sprays.

Replicated experiments were conducted in the field on some crops. These experiments confirmed the resistance of carrots, pumpkins and squashes to pre-emergence aplications and of sweet potatoes and strawberries to early post-transplanting sprays. On the other hand, sweet corn was injured and the yield significantly reduced by a pre-emergence treatment of 4 pounds per acre. Crabgrass, pigweed, and purslane were well controlled by an application of 4 pounds or less per acre but higher rates were required to kill carpetweed. This chemical appeared to have a residual life of six weeks or more and the rate needed for control of a given species was about the same for soils varying from a light sand to a muck.

[1] Purdue University Agricultural Experiment Station, Lafayette, Indiana.

## IMPROVED WEED SEED CONTROL BY PROPER SEALING OF SOIL FUMIGANTS

**Stanley J. Pieczarka and G. F. Warren[1]**

In soil fumigation for weed control an important factor that is often overlooked is that of confining the gaseous vapors in the soil. A literature review revealed that little or no direct information was available comparing different sealing methods. Therefore a study was undertaken to compare sealing methods when using some commercial fumigants. These materials were studied in the field in two soil types, a silt loam and a muck soil. Methyl bromide, released under a polyethylene cover was used as a standard. Telone (1,3-dichloropropene) and chloropicrin were injected and SMDC (Vapam) and allyl alcohol were applied as drenches as well as injected. The sealing methods studied were: no



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seal, compaction, water seal, polyethylene, drench, and drench plus polyethylene. Two weed counts were made, the first two weeks after treatment. The soil was then tilled six inches deep and weed counts were made four weeks later. In every case Telone and chloropicrin were more effective under the polyethylene cover, reductions in weed counts being significant at the one percent level. Vapam and allyl alcohol drenches gave highly significant reductions in weed counts but results with the drench plus polyethylene were even better. When Vapam and allyl alcohol were injected the results under polyethylene were comparable with the drench. With all materials injection followed by a water seal was next in effectiveness. Compaction and no seal gave poor results. The results of this experiment indicated that regardless of the fumigant or the mode of application, polyethylene seals gave significantly higher weed control than any other sealing method studied.

[1] Purdue University Agricultural Experiment Station, Lafayette, Indiana.

## CHEMICAL WEED CONTROL IN SWEETPOTATO PLANTINGS [1]

**J. K. Greig [2]**

Sweet potatoes are an important vegetable crop in Kansas. They often are grown in rotation with vine crops or field crops. Annual weeds frequently are a problem when sweet potatoes follow either vine or field crops. Hand labor is primarily used to remove weeds within the rows of sweet potatoes; therefore chemical methods of weed control would be desirable.

Two separate experiments were conducted during the 1958 growing season, on a loamy-sand soil. In both experiments the chemicals were applied two days after the slips were set, May 23 and 24 on the first planting, June 6 and 7 on the second. A randomized block split-plot design was used. Chemical treatments were applied to whole plots containing subplots of three sweet potato varieties. Varieties used were Lakan, Kandee and Nemagold. The chemicals were applied to entire plots, not bands down the row. The treatments used and the rates of application were as follows Check; Alanap 2 (NPA) at 3 and 6 lb/A; Alanap 20G (NPA) at 20 and 40 lb/A; neburon at 3 lb/A; and 3Y9 (tris-(2,4-dichlorophenoxyethyl) phosphite) at 4 and 8 qt/A. All rates are based on the manufactured product except neburon which is the active ingredient. These chemicals were applied in 50 gal/A of water, except Alanap 20G, which was applied broadcast by hand.

The second experiment was conducted on Kandee variety. After setting the first trial, it appeared that more phytotoxicity was occuring on this variety than others so an additional trial using more rates of application was established. The chemicals were applied in an 18-inch band on the ridges. The treatments were: Check, Alanap 2 at 3, 6 and 9 lb/A; Alanap 20G at 20, 40 and 60 lb/A; 3Y9 at 2, 4 and 6 lb/A; and neburon at 1.5, 3, and 4.5 lb/A. The chemicals were applied in 62 gallons of water per acre with the exception of Alanap 20G which was broadcast by hand. The effectiveness of the chemicals was determined by counting the broad-leafed and narrow-leafed weeds in representative 1 square foot areas of each plot. Three counts were taken in each experiment: June 10, June 20, and July 7 for the first; June 20, June 28, and July 7 for the second. Kinds of weeds in check plots also were recorded. The phytoxicity of the materials on the sweet potato plants was evaluated by recording the number of resets needed. Final determination was the yield of marketable sweet potatoes.

The experiment using the three sweet potato varieties was reset June 9. All dead plants were removed and new plants were used to bring the stand up to 100 percent. The 3Y9 treatment at 8 qt/A reduced the stand significantly for all three varieties. June 10 counts showed that all chemical treatments had significantly fewer narrow-leaf weeds than the check plots. This was also true for the broad-leafed weeds except with Alanap 2 at 3 lb/A. June 20 counts for narrow-leafed weeds showed no significant differences in numbers of weeds; however, all chemically treated plots had a significant reduction in broad-leafed weeds when compared with the check plot. Counts made July 7 again showed all chemically treated plots had fewer broad-leafed and narrow-leafed weeds than check plots. Chemicals were applied over entire plots in this experiment and the middles were cultivated between the June 20 and July 7 counts. After the third count weeds were removed from all plots by hand and the normal cultural practices followed until harvest. Yields of marketable sweet potatoes showed that those treated with Alanap 2 at 3 and 6 lb/A and neburon at 3 lb/A significantly out-yielded check plots. Lakan variety significantly out-yielded Kandee and Nemagold varieties.

In the Kandee experiment, plots were reset June 18. All three 3Y9 treatments killed significantly more plants than any other chemical treatment.

The June 20th counts showed a significant reduction in both broad-leafed and narrow-leafed weeds for all chemically treated plots except Alanap 2 at 3 lb/A. Counts June 28 showed a significant reduction in both broad-leafed and narrow-leafed weeds for all chemically treated plots compared with check plots. Counts July 7 showed no significant difference for narrow-leafed weeds, but significant differences between all chemically treated plots and check plots for broad-leafed weeds. Weeds in all plots were removed by hand in late July, and normal cultural practices followed until harvest. Yield of marketable sweetpotatoes showed that those treated with Alanap 2 at 6 and 9 lb/A, and neburon at 1.5 and 3 lb/A yielded significantly more than check plots. Neburon at 3 lb/A significantly increased yields over any other treatment.

The following weeds were observed in check plots: puncture vine, pigweed, lambsquarters, spurges, climbing milkweed, crabgrass, stinkgrass, yellow foxtail, and barnyard grass. Those weeds were found to some extent in all treated plots, but neburon showed a distinct inability to control prostrate pigweed.

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## SOIL TREATMENT WITH METHYL BROMIDE APPLIED IN THE VAPORIZED AND LIQUID FORMS FOR CONTROLLING WEEDS IN TOBACCO BEDS [1]

**Edward W. Stroube and J. F. Freeman [2]**

Methyl bromide has been used successfully for several years as pre-seeding soil fumigant for killing soil-borne weed seeds, vegetation, and other soil-inhabiting pests. The common method of applying methyl bromide is to introduce the material as a liquid into containers under gas-tight covers and allow it to vaporize. It is necessary that the soil be at least 50° F and the cover remain in place from 24 to 48 hours for this method of application to be successful in controlling weeds in tobacco beds. Several workers have reported that



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methyl bromide was effective as a soil fumigant when introduced under a cover as a gas for a much shorter exposure period.

In early spring, 1958, tests were made at the Kentucky Agricultural Experiment Station, on small tobacco beds in which methyl bromide was applied in the vaporized and liquid forms. The experimental area was 12 x 72 feet, and the soil was a Maury silt loam. There was no cover crop on the area. It was plowed March 6, and rototilled and worked into condition March 28, with a maximum amount of water in the soil. A standard randomized block design with eight treatments, replicated three times, was used. The eight treatments were methyl bromide vaporized at the rate of 1 pound per 100 square feet for exposure periods of 3, 6, 12, and 24 hours; vaporized at ½ pound per 100 square feet for a 12-hour exposure; the liquid at the rate of 1 pound per 100 square feet for periods of 24 and 48 hours; and a check with no treatment.

The 12 x 72-foot bed was divided into 24 plots (2 plots wide by 12 plots long). To form gas-proof partitions between plots, a trench about 1 foot wide and 6 inches deep was opened at each side and the middle length of the bed area. Similar trenches were dug across the bed at 6-foot intervals. The size of each resulting plot was 5.2 x 5.2 feet, or 27 square feet. A plastic cover was spread over the entire bed area and soil was placed on the cover directly above the trenches so that each plot was thoroughly sealed.

Methyl bromide was applied March 29. The temperature of the soil under the plastic cover at 10 a.m. was 45° F when the gas was first released. By mid-afternoon the soil temperature was up to 55° F, but dropped back to 45° F that night and remained constant during the cloudy, rainy weather which prevailed for the remainder of the exposure period. The atmospheric temperature varied from 45° to about 58° F during the time of exposure.

To vaporize the methyl bromide, it was released through a coiled 15-foot length of ¼-inch copper tubing submerged in a 5-gallon container of water at approximately 140° F, maintained by a small gasoline burner. A plastic tube led under each plot cover. This tube was connected to the copper tubing at the time of treatment. The methyl bromide was completely vaporized by this method, as no liquid was detectable at the exit ends of the lead-in tubes. For the plots which were treated with liquid, the methyl bromide was released as a liquid to shallow metal pans in each plot.

As the exposure period expired for each treatment, the plastic cover was unsealed along the outside edge of those plots, allowing any remaining gas to escape.

The bed was raked lightly, and 25 pounds of a 14-14-14 fertilizer was applied per 100 square yards on April 5. Kentucky 16 Burley tobacco seed was seeded on the same day at a rate of 2½ teaspoons per 100 square yards. The bed was boxed, ditched, and canvassed on April 9.

There were no significant differences between treatments in the number of tobacco plants. The mean of all plots was 51 plants per square foot. The differences in size of plants could not be correlated with treatments except that the tobacco plants in the check plots were considerably smaller than all other treatments owing to excessive competition from weeds. A weed count was made on May 15 and 16. The percent control of weeds was calculated from the number of weeds in the treated plots compared to the number from the untreated plots. There were 141 weeds per square foot as an average of the check plots. The reduction of weeds in the treated plots ranged from 95.5 to 98.7 percent. The ½-pound rate of vaporized methyl bromide for a 12-hour exposure period had significantly more weeds than the other treatments. This was the only significant difference between methyl bromide treatments. The results of the experiment are recorded in the following table:

**Weed control with methyl bromide.**

| Treatment period hours | Rate lb/100 sq ft | Weeds per sq ft | Percent control |
|---|---|---|---|
| | Vaporized | | |
| 3 | 1 | 2.3 | 98.4 |
| 6 | 1 | 2.4 | 98.3 |
| 12 | 1 | 1.8 | 98.7 |
| 24 | 1 | 2.0 | 98.6 |
| 12 | ½ | 6.4 | 95.5 |
| | Liquid | | |
| 24 | 1 | 2.0 | 98.6 |
| 48 | 1 | 2.1 | 98.5 |
| Check | | 141.0 | 00.0 |

[1] The investigation reported in this paper is in connection with a project of the Kentucky Agricultural Experiment Station and is published by permission of the Director.

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## SIMAZIN AND RELATED TRIAZINE HERBICIDES

**Edwin O. Schneider**[1]

Simazin (2-chloro-4,6-bis(ethylamino)-*s*-triazine) was synethesized by Gysin and Knusli in the laboratories of J. R. Geigy, Basle, Switzerland. The compound was introduced experimentally to experiment station and other workers in the United States in 1956. Because of the outstanding pre-emergence control of weeds in corn, the research activities were expanded for corn as well as for other agronomic and horticultural crops.

Triazine compounds related to simazin have been under investigation and are showing promise as herbicides in many crops and against aquatic weeds. The structures and solubility of the more promising are listed below in Table 1. This paper will place emphasis on the first three compounds listed.

The general formula is:

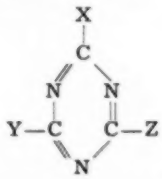


**Table 1. Structure and water solubility of simazin and related compounds.**

| Common name or number | Proposed trade name | Substituted at X | Y | Z | Solubility in water 20°-22°C ppm |
|---|---|---|---|---|---|
| Simazin | Simazine | Cl | $NHC_2H_5$ | $NHC_2H_5$ | 5.0 |
| G-30027 | Atrazine | Cl | $NHC_2H_5$ | $NHiC_3H_7$ | 70.0 |
| G-31435 | Methoxy Propazine | $OCH_3$ | $NHiC_3H_7$ | $NHiC_3H_7$ | ..... |
| G-30028 | Propazine | Cl | $NHiC_3H_7$ | $NHiC_3H_7$ | 8.6 |
| G-28901 | Trietazine | Cl | $NHC_2H_5$ | $N(C_2H_5)_2$ | 20.6 |
| G-30031 | —— | Cl | $NHiC_3H_7$ | $N(C_2H_5)_2$ | 40.0 |

The acute oral toxicities of the triazine compounds in Table 1 have been determined in both rats and mice. The $LD_{50}$ for simazin against both test animals is in excess of 5,000 mg/Kg. The other compounds are in the same range of toxicity although the $LD_{50}$ are somewhat lower than for simazin.

Corn tolerates rates of simazin much in excess of

the amount required for weed kill when applied either as a pre- or post-emergence treatment. It has been demonstrated that the tolerance in corn is due to a decomposition of simazin by enzyme action within the plant shortly after absorption from the soil. Plants mentioned below in Table 2 and many woody species of plants have demonstrated tolerance to simazin. Probably these plants are able to metabolize simazin in the same manner as corn, while susceptible plants either cannot metabolize the chemical or do so at so slow a rate that death of the plant occurs before breakdown of the chemical. Recent experiments indicate that Atrazine is metabolized in corn plants in the same manner as simazin. Corn can tolerate the chloro-triazines tested but is usually killed or severely stunted by the methoxy-triazines.

Table 2 lists the crops showing tolerance to the triazines listed in Table 1.

**Table 2.**

| Triazine | Crops showing tolerance |
|---|---|
| Simazin | Corn, grapes, asparagus, strawberries, pineapple, sugar cane, brambles |
| Atrazine | Corn |
| Methoxy Propazine | Soybeans |
| Propazine | Celery, carrots, sorghum |
| Trietazine | Potatoes, peas tobacco, some varieties of strawberries, lima beans |
| G-30031 | Cotton, carrots |

Seeds in treated soil usually germinate and the seedling is killed following uptake of the chemical by the roots. Kill usually results at, or closely following emergence of the plant from the soil. Death of the plant is dependent on simazin being carried to the root zone by moisture where the uptake occurs. Translocation of the chemical to the leaf inhibits the Hill reaction. The first symtoms are marginal chlorosis followed by necrosis which spreads rapidly until death of the plant occurs. Simazin apparently is not able to penetrate the unbroken cuticle of the leaf.

The action of the other triazines mentioned above appears to be similar to that of simazin in the chlorosis pattern. Atrazine can penetrate the intact leaf of some plants as well as the roots. Methoxy Propazine is very readily absorbed by most plant tissues including Johnsongrass and field bindweed. Atrazine post-emergence has controlled weeds up to 4" high in corn without causing injury.

Since simazin and most of the other triazines are taken up by the roots a sufficient amount of moisture must be present to carry the herbicide to the root zone. To obtain best results, soil moisture should be adequate at the time of application and rainfall or overhead irrigation within 2 weeks is necessary for carrying the herbicide to the root zone. Generally at least ½ inch of rain is required in one shower, although the rapidity of evaporation and soil moisture at application affects the amount required. Atrazine and Methoxy Propazine are more soluble than simazin and appear to require less moisture to be effective.

The insolubility of simazin is important as the chemical is not leached through sandy or heavy clay soils before killing the weeds at the surface. Because of the resistance to leaching and base-exchange capacities of heavy clay loams, more moisture and chemical is needed to reach the germination area of the heavier soils. To achieve weed control for corn, most sandy or sandy loam soils require 1 to 1½ lb actual simazin while 3 lb is generally sufficient on the rich black, clay loams of the corn belt and 4 lb simazin is needed on muck.

Simazin is probably not affected by soil organisms. The herbicidal activity in soil is apparently reduced by absorption on soil colloids, leaching and by cultural practices. Generally a pre-emergence application at the recommended 2 and 4 lb rate on corn will not affect crops planted the following spring after normal plowing and cultivation. Most of the other triazines under test have somewhat less residual activity probably due to their higher water solubility.

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## APPLYING GRANULAR HERBICIDES FOR CONTROL OF WEEDS IN CORN

**W. G. Lovely** [1]

Several years ago research workers found that granular materials impregnated with insecticides were highly successful for controlling several important insect pests. This work has expanded to the point where 50% of the acreage treated for corn borer control in Iowa in 1958 was with granules. Because of the close association of this work with the general field of weed control, it appeared likely that granular herbicides could also be successfully used. In order to investigate this possibility and to develop design requirements for application equipment, field studies with granular herbicides were initiated in Iowa in 1954 and carried forward through 1958.

Granular materials are in essence inert materials such as clay, calcium-carbonate, mica, perlite, celite, etc. These materials are normally ground to size. (We selected a 30/60 mesh material because of the success with this size in the insecticide work.) The toxicants, in this case herbicides, are impregnated onto granules at various percentage levels.

With few exceptions the equipment developed for insecticide work can be readily adapted for herbicide application. In Iowa we used a two-row, fluted-shaft, ground driven applicator. There are, of course, many others that would serve equally well.

Weed control studies using various granular herbicides were conducted in Iowa from 1954-1958. Results have been promising and equipment is being manufactured to apply these materials either separately or in combination with the planting or cultivating operation.

The following general conclusions can be drawn from the field studies:

1. Granular formulations of 2,4-D, CDAA, EPTC, and simazin were as effective as the spray formulations.
2. Under normal conditions working granules into the soil does not improve their effectiveness. However, when the soil surface is dry at application time, working the granules in may improve the weed control.
3. 2,4-D granules at pre-emergence rates can be applied to field corn that has emerged (even up to 36" high) with satisfactory control and little damage. Rates of 2,4-D as high as 8 lb/A in granules have been successfully applied to field corn.
4. Formulations of butyl, iso-octyl, and low-volatile esters and amine of 2,4-D on clay granules applied as pre-emergence treatments gave satisfactory weed control. However, the low volatile ester and amine were not quite as effective as the others.
5. Satisfactory weed control has been obtained by using pre-emergence or early post-emergence applications of granular 2,4-D at the 2 and 4 lb/A rates with only the lay-by cultivation.
6. The heavier granular materials with higher percentages of toxicants appear to be the most efficient and economical from the application equipment and handling standpoint.

**Studies in 1958:** Pre-emergence treatments of granular 2,4-D at 2, 4, and 8 lb/A were approximately equal in effectiveness although the higher rates gave slightly



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better control. Yields and stands were not significantly different and there appeared to be no plant injury even at the 8 lb/A rate.

Similar results were obtained from the post-emergence treatments. The 4 lb/A rate was slightly more effective than the 2 lb/A rate with very little effect on stands or yields.

Simazin granules at the 5 lb/A rate were more effective than the 2½ lb/A rate. Excellent weed control was obtained at the 5 lb/A rate without any cultivations.

Incorporating 2,4-D granules into the soil did not materially change their effectiveness. There was a slight trend towards better control when the soil was worked prior to the granular application.

In order to study the number of granules and types spreading devices needed to obtain adequate soil coverage for weed control, CDAA granules formulated at 25, 12.5, 10, and 6.5 percent were applied pre-emergence on corn at the rate of 4 lb/A of active material. Results show very little difference in stands, yields, or surviving weeds when the treatments were followed with one cultivation. Although the active ingredient is apparently of paramount importance, accurate metering and spreading of a small amount per acre is difficult without expensive equipment.

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## THE USE OF SUBSTITUTED CHLOROBENZOIC ACIDS FOR WEED CONTROL IN SOYBEANS

**M. L. Sutherland and S. R. McLane [1]**

The pre-emergence selective properties of 3-nitro-2, 5-dichlorobenzoic acid were noticed at Amchem Products, Inc., late in 1956. This compound is referred to as "Dinoben." Both 2,5-dichlorobenzoic acid and 2,3,5-trichlorobenzoic acid have been observed to have a low order of activity with little or no crop selectivity. With the introduction of a nitro group in the 3 position, desirable selectivity has been obtained, particularly for soybeans, carrots, and several other horticultural crops. At the same time, many germinating grasses and broadleaved weeds have been controlled.

Much later, an amino substituent in the 3 position was found to produce an equally interesting compound. This compound, 3-amino-2,5-dichlorobenzoic acid, is referred to as "Amoben." Several years ago at Boyce Thompson Institute, research workers found that reduction of the very active 2,6-dichloro-3-nitrobenzoic acid to the amino analogue inactivated the compound. On the contrary, by conversion of the nitro group of Dinoben to an amino substituent certain desirable features are gained.

Preliminary toxicity tests indicate that both Dinoben and Amoben have a low degree of mammalian toxicity. The LD/50 for both compounds was found to be 3.5 grams per kilogram.

Near Ambler, Pa., soybeans were planted June 4 and sprayed with Dinoben and Amoben on June 5. Ten inches of rain fell on these plots during the next eleven weeks. The sodium salt, amine salt, wettable acid powder and granular acid formulations of Dinoben were applied at 4 and 8 lb/A. Only the sodium salt of Amoben was applied at 4 and 8 lb/A. Plots treated with 4 lb/A of Dinoben (all formulations) were free of annual weeds for at least two months. Comparable amounts of Amoben persisted several weeks longer than Dinoben. Response of soybeans from this pre-emergence treatment is summarized in Table 1.

**Table 1. Soybean response to Dinoben and Amoben**

| Chemical | Rate | Description |
|---|---|---|
| Dinoben | 4 lb/A | First trifoliate malformed; later trifoliates normal. Overall growth and yield normal. |
| Dinoben | 8 lb/A | First and second trifoliates malformed; later trifoliates normal. Overall growth and yield normal. |
| Amoben | 4 lb/A | No abnormalities noted. |
| | 8 lb/A | Normal growth and yield. |

Several grasses and broadleaf weeds were planted August 9, 1958, to compare the pre-emergence phytotoxicity of these two chemicals. Dinoben and Amoben were applied four days later at rates of 4 and 8 lb/A. A total of six inches of rain fell on these plots in the next eight weeks. The weed control obtained from these treatments is tabulated in Table 2.

**Table 2. Pre-emergence weed control by Dinoben and Amoben**

| | Percent | | | |
|---|---|---|---|---|
| | Dinoben | | Amoben | |
| Weeds | 4 lb/A | 8 lb/A | 4 lb/A | 8 lb/A |
| Foxtail | 100 | 100 | 100 | 100 |
| Barnyardgrass | 100 | 100 | 100 | 100 |
| Ryegrass | 75 | 100 | 85 | 100 |
| Johnsongrass | 100 | 100 | 100 | 100 |
| Quackgrass | 75 | 85 | 80 | 100 |
| Small crabgrass | 100 | 100 | 100 | 100 |
| Wild oats | 50 | 75 | 75 | 90 |
| Common chickweed | 100 | 100 | 100 | 100 |
| Mustard | 100 | 100 | 100 | 100 |
| Pigweed | 100 | 100 | 100 | 100 |
| Lambsquarters | 100 | 100 | 100 | 100 |
| Ragweed | 100 | 100 | 100 | 100 |
| Velvet leaf | 100 | 100 | 100 | 100 |
| Yellow rocket | 100 | 100 | 100 | 100 |
| Curled dock | 100 | 100 | 100 | 100 |

Although the major herbicidal activity of Dinoben and Amoben is displayed when these chemicals are applied pre-emergence, there is some post-emergence activity present.

This past season Dinoben was tested in seven different states besides Pennsylvania for weed control in soybeans, with results similar to those noted above.

Since there was a very limited quantity of Amoben, it was only tested in three states besides Pennsylvania. Excellent weed control and good residual activity was noted in each case. No injury was reported from any of the pre-emergence treatments. In one instance, Amoben was applied post-emergence with no adverse effects to the soybeans.

The limited number of trials conducted this past season have indicated four advantages that Amoben has over Dinoben for weed control in soybeans:

1. Effective control can be obtained with lower rates of Amoben.
2. When Dinoben and Amoben have been compared at equal rates, longer residual weed control has been obtained from Amoben.
3. Amoben has not caused any injury to soybeans, while in a number of cases, malformation of the first and second soybean trifoliate leaf has been reported from the use of Dinoben.
4. The post-emergence activity of Amoben is considerably more than that of Dinoben.

(1) Amchem Products, Inc., Ambler, Pennsylvania.

## NEBURON FOR PRE-EMERGENCE WEED CONTROL IN GRAIN SORGHUMS [1]

**Ronald E. Talbert and O. Hale Fletchall[2]**

Grain sorghum seedlings grow very slowly and offer little competition to weeds. Because early cultivation of these small seedlings is difficult other effective weed control measures would be especially helpful for this crop. Studies were initiated in 1957 to find a satisfactory pre-emergence herbicide for weed control in grain sorghum. Of the 24 chemicals that have been field tested in the last two years, neburon has been the most promising.

Field studies of various pre-emergence chemicals were conducted on Mexico salt loam near Columbia. Missouri. Only the results for neburon are reported here.

The influence of neburon at three rates, no treatment, and 3 cultivations on weed growth are shown in Table 1.

**Table 1. The influence of neburon on weed growth, 1958**

| Treatment | Av. stand weeds July 1 Plants/24 sq ft | Weed yield at harvest cwt/A |
|---|---|---|
| None (Uncultivated) | 510 | 53 |
| None* (3 Cultivations) | 100 | 8 |
| Neburon 1 lb/A | 192 | 31 |
| Neburon 2 lb/A | 52 | 15 |
| Neburon 4 lb/A | 26 | 8 |

* Not randomized

Weeds common in this experiment included smartweed, spiny sida, ragweed, horse nettle, crabgrass, and fall panicum. Two and 4 pounds of neburon were very effective in early weed control. Four pounds of neburon were necessary to give satisfactory all season weed control without cultivation. One pound of neburon reduced weed yields about 40 per cent, 2 pounds 70 per cent, and 4 pounds 85 per cent as compared with the uncultivated check treatment. Four pounds of neburon was about equal to 3 cultivations. Neburon was found to be slightly more effective on broad-leaved weeds than grasses. It was estimated from weekly observations of per cent ground not covered by weeds that 1 pound of neburon held weeds without cultivation for 4 weeks after treatment, 2 pounds neburon for 6 weeks, and 4 pounds of neburon for 9 weeks.

The data in Table 2 indicate that neburon had no appreciable influence on the stand and height of grain sorghum even at the 4 pound rate.

**Table 2. The influence of neburon on stand, height, and yield of Westland grain sorghum**

| Treatment | Stand 1000 stalks/A | Height July 6 in | Yield bu/A |
|---|---|---|---|
| None (Uncultivated) | 59 | 32 | 26 |
| None* (3 cultivations) | 46 | 31 | 57 |
| Neburon 1 lb/A | 50 | 31 | 42 |
| Neburon 2 lb/A | 48 | 31 | 62 |
| Neburon 4 lb/A | 49 | 30 | 65 |
| L.S.D. 5% level | | | 17 |
| L.S.D. 1% level | | | 24 |

* Not randomized and not included in analysis of variance.

The influence of neburon and 0, 1, and 2 cultivations on the yield of weeds and sorghum are shown in Table 3. These results are from another experiment.

**Table 3. The influence of neburon and cultivation on yields of weeds and sorghum.**

| Treatment | No. of culti. | Weed yield cwt/A | Sorghum yield bu/A |
|---|---|---|---|
| None | 0 | 64 | 6 |
| | 1 | 33 | 24 |
| | 2 | 27 | 48 |
| 2 lb/A neburon | 0 | 14 | 70 |
| | 1 | 6 | 78 |
| | 2 | 2 | 80 |

The 2-pounds-neburon-alone treatment was still quite weedy. One cultivation where neburon was used reduced weed growth enough that weeds would not interfere with harvesting. It should be pointed out that cultivations were less effective than normal due to the wetness of the season during the time of cultivations. Weed competition on unsprayed plots caused severe reductions in yields. Where neburon was used, 1 cultivation was about equal to 2 cultivations.

It was questioned whether grain sorghum was physiologically resistant to neburon or was escaping the effects of the herbicide in some other way. In greenhouse studies, grain sorghum plants were severely stunted in 16 days when grown in cultures containing 10, 100, and 1000 ppm of neburon. Twenty-six days after treatment when the plants were harvested very few of the plants at these concentration levels were still living. When the toxicity of neburon and 2,4-D to grain sorghum was compared, there was very little difference.

[1] Contribution from the Missouri Agricultural Experiment Station, Journal Series No. 1944. Approved by the Director.

[2] Graduate Assistant, and Associate Professor of Field Crops.

## BENZOIC ACIDS FOR PRE-EMERGENCE WEED CONTROL IN CORN [1]

**O. Hale Fletchall and Ronald E. Talbert [2]**

As good as 2,4-D is, a chemical lacking some of its shortcomings would be a welcome addition to the chemical tools for pre-emergence weed control in corn. In 1955 the chlorobenzoic acids appeared promising enough to be included in our research program.

Materials high in 2,3,6-TBA (approximately 60 per cent) and chlorinated benzoic acid materials low in 2,3,6-TBA (approximately 3 per cent) were compared with each other and with 2,4-D. Comparisons were made in 4 experiments in the years 1955-1957. In two experiments in 1955, the sodium salt and the acid forms of the high 2,3,6-TBA material were compared.

Kansas 1639 hybrid corn was planted early in May on heavily fertilized land. The experiments were of a randomized complete block design with 4 replications. A plot consisted of two 40-inch rows of corn 32 ft. long. Herbicides were applied on the day of planting or on the day following. None of the plots were cultivated. Early weed counts were made about 4 weeks after planting in four 6- by 36-inch quadrats per plot. Predominating weeds were crabgrass, foxtails, pigweed, lambsuarter, smartweed, and carpetweed. Shortly before corn harvest, the weeds were harvested from four 20- by 30-inch quadrats per plot, separated into weedy grasses and broad-leaved weeds, dried to constant weight at 100°C, and weighed.

Table 1 shows the results of weed counts taken about 4 weeks after treatments. Two lb/A of 2,4-D were very effective in controlling the heavy weed infestation. The



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**Table 1. Weed stands 4 weeks after treatment**

| Treatment | Plants per square foot | | |
|---|---|---|---|
| | Grass | Bd-lvd | Total |
| None | 142 | 53 | 195 |
| 2,4-D ester (2 lb/A) | 2 | 3 | 5 |
| High 2,3,6-TBA (2 lb/A) | 9 | 3 | 12 |
| Low 2,3,6-TBA (2 lb/A) | 66 | 6 | 72 |

material high in 2,3,6-TBA was almost as effective as 2,4-D. The material low in 2,3,6-TBA was not as effective as the high 2,3,6-TBA material especially on weed grasses. This poorer showing of the benzoic acids than 2,4-D for weed grass control has been observed in other experiments and is further substantiated in Table 2.

**Table 2. Yields of weeds and corn at harvest**

| Treatment | Yield weeds cwt. per acre | | | Yield corn bu/A |
|---|---|---|---|---|
| | Grass | Bd-lvd | Total | |
| None | 20 | 24 | 44 | 30 |
| 2,4-D ester (2 lb/A | 5 | 14 | 19 | 72 |
| High 2,3,6-TBA (2 lb/A) | 12 | 1 | 13 | 76 |
| Low 2,3,6-TBA (2 lb/A) | 21 | 4 | 25 | 65 |

The untreated check produced a ton of oven-dry weed grasses and almost one and one-fourth tons of broad-leaved weeds per acre. Two lb/A of 2,4-D ester reduced weed grass yields 75 per cent and broad-leaved weed yields a little over 40 per cent. Total weed yields were reduced over 55 per cent. The high 2,3,6-TBA treatment resulted in 1200 pounds of weed grasses per acre but only 100 pounds of broad-leaved weeds. The less effective benzoic material allowed as much weed grass growth as occurred on the check and only 400 pounds of broad-leaved weeds per acre. The heavy growth of weed grasses on the plots receiving the benzoic acid treatments is a result of (1) only fair chemical control of the weed grasses and (2) good control of broad-leaved weeds reducing their competition. Corn yields varied directly with weed control. Although these experiments were not designed to detect small differences in chemical injury to corn, the close correlation of corn yields to weed control indicates that the benzoic acids did not affect corn appreciably differently from 2,4-D.

Table 3 shows the average weed stands about 4 weeks after treatment of the two experiments comparing the sodium salt and the acid forms of 2,3,6-TBA. There was only a slight tendency for the acid to be more effective

**Table 3. Weed stands 4 weeks after treatment**

| Treatment | Plants per square foot | | |
|---|---|---|---|
| | Grass | Bd-lvd | Total |
| None | 237 | 53 | 290 |
| Na salt | 16 | 2 | 18 |
| Acid | 12 | Trace | 12 |

than the sodium salt on both weed grasses and broad-leaved weeds. The same is true in the case of weed grass yields at harvest time as shown in Table 4. It has been

**Table 4. Yields of weeds and corn at harvest**

| Treatment | Yield weeds | | | Yield corn bu/A |
|---|---|---|---|---|
| | Grass | Bd-lvd | Total | |
| None | 34 | 3 | 37 | 24 |
| Na salt | 21 | Trace | 21 | 72 |
| Acid | 16 | Trace | 16 | 67 |

observed that these materials are not consistently so nearly equal for weed control. Sometimes the acid is more effective and sometimes the sodium salt is more effective. The materials had a great effect on the yield of corn in these weedy situations. The difference in the performance of the two forms of 2,3,6-TBA was small.

[1] Contribution from the Missouri Agricultural Experiment Station, Journal Series No. 1941. Approved by the Director.

[2] Associate Professor and Graduate Assistant of Field Crops.

## COMPARISON OF AMINE AND ESTER FORMULATIONS OF 4-(2,4-DB) FOR WEED CONTROL IN ALFALFA

**Elroy J. Peters** [1]

The herbicide 4-(2,4-DB) was introduced in 1955. This experiment was designed to compare several rates of ester and amine to determine the rate of each necessary for effective weed control with the least injury to alfalfa.

Ranger alfalfa was sown with a cultipacker seeder on April 14, 1957, and April 8, 1958, at the rate of 12 pounds per acre. Plots were 7 feet wide and 20 feet long laid out in a randomized block design. An amine and an ester formulation of 4-(2,4-DB) applied at rates of ½, 1, and 2 lb/A in 40 gal/A of water. A 1-pound rate of each formulation was also applied mixed with the sodium salt of dalapon at 2 lb/A. These materials were applied on May 27, 1957 and May 28, 1958 when the alfalfa was 6 to 8 inches tall. Smartweeds were about 6 to 10 inches and pigweeds 4 to 8 inches tall. Yields of alfalfa were taken at the hay stage from a strip 3 feet wide and 20 feet long. The percentages of weeds and alfalfa in the forage were determined by hand separating the first cutting and by visually estimating the later cuttings.

Lower yields of alfalfa resulted in 1957 from plots treated with 4-(2,4-DB) ester than from plots treated with the amine (Table 1). The 2-pound rate of both formulations reduced the yield of alfalfa compared with the 1-pound rate. The 1-pound rate of 4-(2,4-DB) ester reduced yield as compared with the ½-pound rate of ester or the 1-pound rate of amine. The best yield of alfalfa was obtained on plots treated with 1 pound of 4-(2,4-DB) amine. The addition of 2 pounds of dalapon to 1 pound of 4-(2,4-DB) reduced the yield of alfalfa appreciably. Broad-leaved weed control was satisfactory at all rates as compared with the check and there was little difference between the weed control by the formulations at a given rate except at the ½-pound rate where the ester was better than the amine. The addition of dalapon reduced the amount of weed grasses appreciably.

In 1957, the 2-pound rate of both 4-(2,4-DB) formulations aparently injured the alfalfa sufficiently so that yields were depressed in the second cutting.

**Table 1. Yields of alfalfa and weeds, June 20, 1957.**

| | Rates/A 4-(2,4-DB) lb/A | Dalapon lb/A | Alfalfa lb/A | Bd-lvd weeds lb/A | Weedy grasses lb/A |
|---|---|---|---|---|---|
| Amine | ½ | — | 1614 | 241 | 286 |
| | 1 | — | 1964 | 108 | 164 |
| | 2 | — | 1655 | 24 | 325 |
| | 1 | 2 | 1201 | 89 | 23 |
| Ester | ½ | | 1594 | 161 | 408 |
| | 1 | | 1486 | 115 | 278 |
| | 2 | | 1216 | 21 | 365 |
| | 1 | 2 | 1217 | 69 | 19 |
| Check | | | 1460 | 1003 | 211 |
| LSD 5% | | | 303 | 240 | 134 |
| 1% | | | 411 | 327 | 183 |

In 1958 the ester formulation was more effective in controlling broad-leaved weeds at the ½ and 1-pound



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rates that the amines (table 2). Weed control was about the same for the two formulations at the 2-pound rate. One pound of the amine was about as effective as ½ pound of the ester. The ester again was more injurious to the alfalfa than the amine. Although broad-leaved weed control with 1 pound of ester was appreciably better than that with 1 pound of the amine, the alfalfa yields were less where the ester was used. The use of 2 pounds of dalapon in addition to 1 pound of 4-(2,4-DB) eliminated grasses but was injurious to alfalfa.

**Table 2. Yields of alfalfa and weeds, July 1, 1958.**

| | Rates/A 4-(2,4-DB) lb/A | Dalapon lb/A | Alfalfa lb/A | Bd-lvd weeds lb/A | Weedy grasses lb/A |
|---|---|---|---|---|---|
| Amine | ½ | — | 863 | 1861 | 46 |
| | 1 | — | 1697 | 728 | 62 |
| | 2 | — | 1547 | 196 | 131 |
| | 1 | 2 | 1119 | 325 | 6 |
| Ester | ½ | — | 1505 | 790 | 44 |
| | 1 | — | 1544 | 244 | 93 |
| | 2 | — | 1283 | 213 | 72 |
| | 1 | — | 1331 | 314 | 72 |
| Check | | | 443 | 3159 | 31 |
| LSD 5% | | | 236 | 458 | — |
| 1% | | | 320 | 623 | — |

The injury to alfalfa caused by the 2-pound rate of both formulations and the 1-pound rate of ester reduced yields in the second cutting.

The data in general showed that good weed control and optimum yields of alfalfa were obtained by the use of 1 pound of 4-(2,4-DB) amine. When weed infestation was severe, 2 pounds of the amine gave appreciably better weed control but reduced alfalfa yields somewhat. The ester was more injurious to alfalfa than amine. One-half pound of the ester was about equal to 1 pound of the amine for controlling weeds and the ester was more injurious to the alfalfa.

[1] Agronomist, Crops Research Division, Agricultural Research Service U. S. Department of Agriculture and Missouri Agricultural Experiment Station.

## THE ROLE OF HERBICIDES IN THE ESTABLISHMENT OF LEGUME STANDS

**H. A. Friesen** [1]

The establishment of strong, vigorous stands of legumes in western Canada, either alone or in mixture with grasses, is faced with two formidable hazards, climate, and weed competition. Experience has shown that stronger, more productive stands are obtained where the legumes and/or grasses are sown without a companion crop. Investigations were begun at the Lacombe Experimental Farm nearly ten years ago to assess various phenoxyacetic herbicides as a means of eliminating weed competition.

During the period 1948 to 1955 the trials were sporadic, very limited in scope and largely observational in nature. In 1956 the ester formulations of 4-(MCPB) and 4-(2,4-DB) were compared with various formulations of MCPA and 2,4-D on oats and undersown with bands of alfalfa, red clover and sweet clover. The phenoxybutyric formulations were applied at dosages of 6, 12, and 18 oz/A, while the phenoxyacetic formulations were applied at 3 and 6 oz/A. Hemp nettle was the major weed species. The infestation was heavy, yielding upwards of 1000 lb/A, dry weight, on the untreated plots. Furthermore, at the time of spraying the young nettles formed a dense canopy over the legume seedlings. Although the MCPA and 4-(MCPB) formulations at the early date of spraying (4-6 leaf stage of the nettle) resulted in nearly complete suppression of the hemp nettle, while the 4-(,4-DB) and 2,4-D amine gave no control of this weed, none of the treatments significantly increased the yield of either alfalfa or red clover in the following season of 1957. Plant counts revealed that the stand of legumes on the untreated plots was about 66 per cent while on the treated plots it was upwards of 80 per cent of the stand on the hand-weeded control plots. The legume yields in 1957, following the above treatments made in 1956 when the hemp nettle was in the bud stage, were not significantly different from those after the early treatment.

In 1957 a similar trial was laid down on alfalfa and sweet clover seeded with and without a companion crop of oats. Red clover and alsike clover were only seeded with the companion crop. The dosages of the various formulations of 4-(2,4-DB) and 4-(MCPB) used were 8, 16, and 32 oz/A. During the early growth stages in 1958 alfalfa (seeded without a companion crop) and treated at the 2-trifoliate-leaf stage with ester, amine or sodium salt formations of 4-(2,4-DB) appeared outstanding in number and vigor of plants. This field observation was borne out by significantly higher yields than the untreated plots. The ester and the sodium salt of 4-(MCPB) at 32 oz/A depressed the alfalfa yield. All treatments resulted in upward of 60 per cent control of weeds, dry weight basis. The major weed species were stinkweed, ball mustard, lambsquarters and wormseed mustard; hemp nettle was of minor importance. Dry weight of weeds on the untreated plots averaged 984 lb/A.

The sweet clover stand was severely reduced by weevils in 1957. While this permitted a stronger growth of weeds the control was not unlike that noted on the alfalfa plots. Sweet clover yields were greatly improved as a result of the weed control effected by all treatments, except the ester formulations of 4-(2,4-DB) and 4-(MCPB). At 32 oz/A these treatments virtually eliminated the sweet clover.

Two cuts of alfalfa were taken in 1958. No significant differences due to any of the treatments could be shown. With sweet clover there was a trend to higher yields as a result of treatment with all amine and sodium salt formulations while treatment with the ester formulations resulted in marked yield reductions. While no significant difference due to treatment could be shown in the alfalfa seeded with the companion crop the yields were about 20 per cent lower than where the companion crop was not used. The yields of red clover and alsike clover, sown with the companion crop, were not differentially affected by any of the treatments made in 1957.

The evidence obtained to date has shown that legumes will tolerate sufficient phenoxy herbicides to suppress if not kill the common annual weeds. This suppression has been great enough to give increased yields of forage in the establishment year, where seeding was done without a companion crop. Here the amine and sodium salts of 4-(MCPB) and 4-(2,4-DB) enjoyed a slight advantage over the amines of MCPA and 2,4-D. The failure of this advantage to be reflected in the yields of forage in the following year would make the additional cost of using the butyric formulations appear of doubtful value.

[1] Senior Agronomist, Experimental Farm, Lacombe, Alberta

## EPTC AND NEBURON FOR WEED CONTROL IN SEEDLING ALFALFA

**Elroy J. Peters** [1]

Small-seeded legumes sown alone in the spring are generally eliminated by competition from weeds. To reduce the amount of weeds these legumes have generally been sown with a small-grain companion crop, which often is as competitive as the weeds. The pos-



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sibilities of using herbicides to establish alfalfa in the spring have been explored in the experiments.

Ranger alfalfa was sown on April 15, 1957, and on April 7, 1958, at a rate of 12 pounds per acre. Seeding was done on a fertile Mexico silt loam soil with a cultipacker seeder. Plots 7 feet wide by 20 feet long were arranged in a randomized-block design, with two replications in 1957 and four replications in 1958.

Plots were treated in both years with EPTC at 5, 10, and 15 lb/A and with neburon at 1 and 2 lb/A. In 1958 EPTC was also applied at 1 and 2 lb/A and disked into the soil before seeding. All herbicides were applied in a spray volume of 40 gal/A.

Prolonged rains occurred immediately after seeding in 1957, and the application of herbicides was delayed until the unifoliolate leaf was present on many alfalfa seedlings. In 1958 the herbicides were applied the day of seeding.

When the alfalfa reached the hay stage yields were determined by harvesting a 3-by-20-foot strip from each plot. Percentages of weeds and alfalfa were determined by hand separating a representative sample of the first cutting from each plot each year and by visually estmimating the late cuttings. The major weeds present were smartweeds and pigweeds.

Weeds were completely eliminated from the first cutting in 1957 on plots treated with 2 pounds of neburon, and only small quantities of weeds remained in plots treated with 1 pound (table 1). EPTC at all rates reduced the yields of weeds considerably, but was not satisfactory. Smartweeds were relatively unaffected by early post-emergence treatments with this herbicide. All plots treated with herbicides yielded more alfalfa than the check plots.

**Table 1. Yields of seedling alfalfa and weeds, June 20, 1957.**

| | Rate lb/A | Yields lb/A | | |
|---|---|---|---|---|
| | | Alfalfa | Bd-lvd weeds | Weed grass |
| EPTC | 5 | 1278 | 1435 | 20 |
| EPTC | 10 | 1561 | 731 | 64 |
| EPTC | 15 | 1767 | 1065 | 0 |
| Neburon | 1 | 1444 | 137 | 126 |
| Neburon | 2 | 1380 | 0 | 0 |
| Untr. check | | 1165 | 2196 | 125 |
| LSD 5% | | 397 | — | — |

Broad-leaved weeds were of little consequence after the first cutting. Neburon at 2 lb/A and EPTC at 15 lb/A reduced the yields of grasses late in the season.

In 1958 all herbicides reduced broad-leaved weeds considerably in the first cutting (table 2). The pre-emergence treatments with 15 pounds of EPTC and 2 pounds of neburon and the pre-planting treatment with 2 lb/A of EPTC were outstanding. Neburon was not effective in controlling grasses but the higher rates of EPTC and the pre-planting treatments eliminated grasses. Weeds were not abundant after the first cutting on all plots with herbicides but pre-planting treatments with 1 and 2 lb/A of EPTC were most effective in controlling weed grasses.

**Table 2. Yields of seedling alfalfa and weeds, June 16, 1958.**

| | Rate lb/A | Yields lb/A | | |
|---|---|---|---|---|
| | | Alfalfa | Bd-lvd weeds | Weed grass |
| EPTC | 5 | 1457 | 310 | 5 |
| EPTC | 10 | 1477 | 325 | 0 |
| EPTC | 15 | 1657 | 21 | 0 |
| EPTC (inc.) | 1 | 1700 | 200 | 0 |
| EPTC (inc.) | 2 | 1872 | 126 | 0 |
| Neburon | 1 | 1512 | 242 | 64 |
| Neburon | 2 | 1683 | 52 | 31 |
| Untr. check | — | 673 | 1361 | 65 |
| LSD 5% | | 362 | — | — |

These experiments showed that weed competition can be nearly eliminated and successful stands of alfalfa can be established by spring seeding when pre-emergence herbicides are used. Valuable yields of high-quality hay can also be obtained the seedling year when weed competition is reduced.

[1] Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture and Missouri Agriculture Experiment Station.

## THE PRESENT STATUS OF CHEMICAL FALLOW IN THE GREAT PLAINS [1]

**A. F. Wiese, J. J. Bond and T. J. Army [2]**

Since the spring of 1955 various phases of chemical fallow research have been investigated at the Southwestern Great Plains Field Station, Bushland, Texas. The soil type at the station is Pullman silty clay loam, and the average annual rainfall is aproximately 18 inches. Experiments have been conducted to determine the most effective herbicides on common annual weeds and volunteer wheat and sorghum. The effect of chemical fallow on crop yields, soil moisture storage, and the potential wind erodibility of the soil has been investigated.

Control of Russian thistle, kochia and puncture vine was readily obtained with 1 pound per acre of a propylene glycol butyl ether ester formulation of 2,4-D. The sodium salts of dalapon and trichlorocetic acid applied at 5, 10 or 15 pounds per acre did not give satisfactory control of stinkgrass and witchgrass. No weed control was obtained from 2 or 4 pounds per acre of monuron.

Volunteer wheat and sorghum growing under moisture stress were not satisfactorily controlled with chemicals. The toxicity of dalapon was increased by supplementing the water carrier with either wetting agent or diesel oil. Amitrol was more toxic to volunteer wheat than to volunteer sorghum. Maleic hydrazide was not effective in controlling volunteer wheat but moderately effective against sorghum.

Yields of wheat and sorghum from chemical fallow plots were usually less than yields from plots where weeds were controlled with sweep tillage. Lower grain yields on the chemical fallow plots probably resulted from inadequate grass weed control which reduced soil moisture storage during fallow periods. Because more residues remained on plots where weeds were controlled chemically, potential wind erodibility was reduced.

[1] Joint contribution from the Texas Agricultural Experiment Station and Soil and Water Conversation Research Division, Agricultural Research Service, United States Department of Agriculture. Approved as TAES T.A. 3071.

[2] Respectively, Associate Agronomist, Texas Agricultural Experiment Station and Soil Scientists, Soil and Water Conservation Research Division, Agricultural Research Division, United States Department of Agriculture, Southwestern Great Plains Field Station, Bushland, Texas.

## LIFE HISTORY OF LEAFY SPURGE

**G. W. Selleck [1]**

Life history studies of leafy spurge were carried out during a ten-year period in the laboratory, in field plots at the University of Saskatchewan and where the plant had established itself in a variety of habitats throughout Saskatchewan.

Maximum germination of seed of *E. esula* occurs after it has reached an age of one year, in field and laboratory. Seeds may germinate in soil after five years, but 99% of the germination occurs within the first two.



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Viability may be retained for at least 13 years in the laboratory.

Seeds were planted in the field at the surface and at 0.25 in. intervals for the first inch and at 1-in. intervals to a depth of 6 in. Although germination occurred at each level, highest germination percentages were obtained at two depths, 0.5 and 2 in. Under field conditions, 99% of the seed germinates in May and June, with some germination occurring until September. The maximum flush of germination appears to be correlated with the first prolonged warm period in the spring.

Seed collected from different locations exhibits different degrees of dormancy. Percentage germination increases with temperatures. Maximum germination occurs at 30° to 32° C., which is in agreement with data obtained by other workers. Alternate freezing and thawing, wetting and drying, and prolonged dark periods promote germination; scarification does not. Clay soils appear to be more conducive to germination than soils of lighter textures.

Brown seeds are more mature, therefore larger and heavier, germinate more completely, and imbibe less water than grey seeds. Germination does not necessarily occur after imbibition of water.

At an age of 7 to 10 days, the seedlings produce vegetative buds, thus developing the perennial habit. The seedling continues to develop throughout the season, but an inflorescence is not produced the first year. Plants may, however, reproduce vegetatively the first year. Plants which originate from roots and rhizomes begin growth in Saskatchewan in late April, usually flowering by May 10, and produce seed in about seven weeks. As the patches develop, density reaches more than 200 shoots per square meter in light soils, and up to 2000 per square meter in heavy soils. On heavy soils, a considerable proportion (60%) of these shoots are produced from seed. Density usually reaches a maximum in June or July, but under favorable moisture conditions may be sustained until late August. On light soil textures, the density of the weed is maintained and increased mainly by vegetative reproduction. Seed capsules explode upon maturity, propelling seeds distances up to 15 ft. Reproduction by seed is important in the establishment of additional patches of the weed beyond the perimeter of the main infestation. Seed production is normally terminated by mid-August, but under favorable moisture conditions will continue until freeze-up.

The density of *E. esula* was studied in competition with various species. The plant is capable of becoming established in a small disturbed area, for example a gopher mound, and continuing invasion of ungrazed, climax grassland. It is capable also of invading areas which are dominated by buckbrush, by aspen groves in Saskatchewan and oak woods in Wisconsin. As light becomes more limiting, spurge plants fail to flower, decrease in density and increase in height until light is sufficiently limiting to prevent survival.

The introduced grasses crested wheatgrass and smooth bromegrass were not capable of decreasing the density of established patches of the weed, during a five-year period. When *Agrupyron cristatum* was established in a sparse stand of *E. esula*, the density of the weed, though increasing, was greatly restricted. Native species of grass maintained densities of *E. esula* at a much lower level than the introduced ones.

Radial spread of patches of *E. esula* varies between 0.5 and 11 ft annually, occurring mainly in June. If favorable moisture conditions are maintained, however, vegetative spread may continue until mid-August. *Bromus inermis* and *A. cristatum* were more effective in limiting vegetative spread of patches *of E. esula* than native species of grass. The rate of spread is considerably greater when one considers reproduction simultaneously by both rhizomes and seed. A total infested area of 1056 sq. ft. in grassland increased by 41 times during a period of five years.

Plant parts of *E. esula* were removed to various depths in soil, to a maximum of 3 ft. The holes were cribbed with bottomless, steel barrels and replaced with tamped, uninfested soil. Roots which were located at 3-ft. depths were capable of penetrating the uninfested soil within one season, but failed to survive. At depths of 2 ft. plants which emerged became permanently established.

There is evidence to suggest that *E. esula* and *Antennaria* spp. exhibit antibiotic effects on certain competing species in nature.

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## LEAFY SPURGE SEED MATURATION STUDIES

**G. A. Wicks and L. A. Derscheid** [1]

Three factors were studied: (1) seed color, (2) age when seeds are viable, and (3) the effect of mowing and 2,4-D on seed production.

**Seed color.** Two experiments were conducted in June and July of 1957 to learn the reason for the color variation of leafy spurge seeds. In each month the plants were marked with colored tags upon removing the inverted or exposed capsules. A different color tag or symbol was used for each day. The plants were examined daily and when the capsules were inverted over the cyathia the date was recorded.

Upon harvesting, several different colors of seeds were observed. They corresponded with the maturity of the seed. A chronological sequence of age with the capsule in relationship to seed color follows. As the seed increased in age, the color of the seeds changed from yellow to yellow with brown tips. The brown then moved in from both ends until a narrow yellow band was present. These seeds were called yellow stripe. The stripes changed to orange giving the seeds an orange-brown appearance. As the orange became darker, the seeds appeared reddish-brown and later brown. From brown, the seeds change to gray. First, a gray line developed along one side of the seeds. This gradually became larger until the seeds were gray-brown in color. The seeds then lost the brown color and became all gray. Tiny brown spots then began to appear on the seeds giving them a slightly mottled gray appearance. The brown spots gradually increased until the seeds were distinctly mottled. In some instances, shades of green appeared between the gray and the mottled. Also, some of the mottled seeds were much darker than the others.

In germination studies, the results indicated that seeds younger in maturity than brown were not viable. The mean germination for the two experiments was: brown seeds 16%, gray-brown 62%, gray 77%, and mottled 73%.

The average weight of brown, gray and mottled seeds harvested in June was 182.0, 254.5, 301.5 mg/100 seeds respectively. In August, the average weight of gray seeds was 269.2 mg/100 seeds and of mottled seeds 288.6 mg/100 seeds.

**Age when seeds are viable.** The first brown seeds were present on the 12th day after the capsules had inverted in the June experiment and the 10th day in the July experiment. The first germination of these seeds occurred on the 16th and 13th respectively for the two experiments. In the June experiment, there was no increase in germination until the 21st day in which it was 33%. At this time the majority of seeds were brown and gray-brown. In the July experiment, there was an increase in the germination on the 15th day. This was the day previous to when gray-brown and gray were the predominant colors. The germination on the 15th was 58%.

**Effect of mowing and 2,4-D on seed production.** Since the first germination occurred on the 13th day after



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capsules have inverted, it may be interpreted that mowing must be accomplished by this date to prevent viable seeds. It would be advisable to complete mowing by the 10th day since this is when the first brown seeds occurred.

Leafy spurge was sprayed with ½ lb/A of 2,4-D ester in July of 1957. Untreated spurge was also maintained. Capsules that were 1-18 days old at the time of spraying and capsules that inverted the day of spraying and 1-3 days after spraying were harvested. Capsules were harvested at maturity. This was at the time when they began to crack down one side of the capsule. This occurred in 9-25 days for the treated and 19-24 for the untreated.

The first viable seed produced from plants sprayed with 2,4-D was from capsules that were 6 days old at spraying time. Germination at this time was 3% When spraying was delayed until the 9th day germination was 10%; one day later it was 26%. The total viable seeds that were 10 days old or less when spraying occurred was 9% for the treated and 54% for the untreated spurge.

The sprayed plots contained a large number of immature seeds. Based on color, 19% were immature compared with 2% for the untreated for the entire experiment. Capsules that were 7, 8, 9, and 10 days old at spraying time produced 89%, 47%, 18% and 4% immature seeds respectively.

The corresponding ages for the untreated leafy spurge produced 6%, 3%, 0%, and 2% immature seeds respectively.

Spraying with ½ lb/A of a 2,4-D ester, spray must be applied before the sixth day after the capsules have inverted to stop the production of viable seeds.

[1] Graduate Assistant, and Associate Agronomist, respectively, South Dakota State College.

## SEASONAL ACTIVITY OF THE REPRODUCTIVE BULBS OF WILD GARLIC IN A NATURAL POPULATION [1]

**J. F. Freeman and J. M. Kavanaugh [2]**

Wild or field garlic is a perennial which reproduces by aerial bulblets, three types of underground bulbs, and occasionally by true seed. Studies on which the present report is based were made to obtain better information upon seasonal activity of the reproductive bulbs of this plant as a basis for the use of foliage application of herbicides, such as 2,4-D, in the control program. Samples of wild garlic bulbs and the soil containing them were taken semi-monthly during one active season from September 15, 1956 to July 7, 1957, in a heavily infested third-year alfalfa meadow, except that samplings during January were omitted due to waterlogged or frozen condition of the soil. Ten to 15 blocks of soil 3 to 5 inches square and 6 inches deep (containing bulbs and plants) were taken at each sampling in the attempt to include at least 500 bulbs. The average number obtained per sampling was 997. The bulbs of each sampling were separated from the soil, and classified as to type of activity as follows: (1) dormant, (2) sprouted (leaves not above ground), (3) producing small plants—less than 6 inches tall, and (4) producing large plants—6 inches or taller. Classifications 1, 2 and 3 each were subdivided into the recognizable types of bulbs—hard-shelled, terminal, and aerial. The number of bulbs in each classification was obtained and their percentage of the total determined. The changing percentages of bulbs in the various classifications at successive sampling dates were used as a measure of activity changes. To determine the time of initiation of new off-set bulbs within parent bulbs, those having tops above ground were cross-sectioned beginning with the February samplings. Data for the 4 main classes of bulb activity are shown in the table.

**Activity of reproductive bulbs of wild garlic at semi-monthly intervals during the 1956-57 season**

| | Percent of total number in sample | | | |
|---|---|---|---|---|
| | | | Bulbs producing | |
| Date of sample | Dormant bulbs | Sprouted bulbs | Small plants | Large plants |
| Sept. 15 '56 | 45 | 8 | 17 | 30 |
| Sept. 29 | 36 | 3 | 40 | 21 |
| Oct. 15 | 37 | 3 | 28 | 32 |
| Oct. 31 | 24 | 7 | 42 | 27 |
| Nov. 17 | 33 | 7 | 32 | 28 |
| Nov. 29 | 23 | 7 | 45 | 25 |
| Dec. 15 | 35 | 1 | 41 | 33 |
| Jan 1 and Jan. 15, 1957 not sampled due to wet or frozen soil conditions | | | | |
| Feb. 1 | 26 | 27 | 22 | 25 |
| Feb. 14 | 26 | 22 | 26 | 26 (1) |
| Mar. 1 | 26 | 17 | 31 | 26 |
| Mar. 14 | 31 | 7 | 26 | 36 |
| Mar. 29 | 27 | 4 | 27 | 42 |
| Apr. 15 | 22 (2) | 6 | 10 | 62 |
| May 1 | 30 | 18 | 16 | 36 |
| May 20 | 89 | 0 | 0 | 11 |
| May 31 | 88 | 0 | 0 | 12 |
| June 18 | 93 | 0 | 0 | 7 |
| July 9 | 92 | 0 | 0 | 8 |

(1) Initiation of new off-set bulbs was beginning in some large plant bulbs. (2) New hard-shelled bulbs had begun to separate from parent bulbs, and were 1.5% of all bulbs present.

All soft-shelled bulbs and terminal bulbs had germinated and most of them were growing vigorously by November. Germination of aerial bulblets was at a rapid rate in September, then practically ceased until February when the rate increased, then at a low rate until the last of April. Hard-shell bulbs germinated at a low rate during fall and early winter then at a high rate during January—22% of all bulbs present being sprouted hard-shells at the February 1 sampling which followed a month of freezing weather. Their germination did not entirely cease until the end of April. At the time of the April 15 sampling, ungerminated hard-shell bulbs amounted to only 20% of population which was the lowest of the season, new off-set hard-shells were just beginning to separate from parent bulbs, and bulbs of all types with leaves above ground were at a maximum—about 70%. Leaves of bulbs which later produced central terminal bulbs began dying back shortly after April 15. These new terminal bulbs composed a third of the total population by the May 20 sampling.

[1] This investigation is in connection with a project of the Kentucky Agricultural Experiment Station and is published by permission of the Director.

[2] Associate Agronomist, Kentcky Agricultural Experiment Station; and Assistant County Agricultural Extension Agent, University of Kentucky Agricultural Extension Service, Princeton, Kentucky; formerly Graduate Assistant in Agronomy.

## VARIATIONS IN THE SENSITIVITY OF CLONES OF QUACKGRASS TO DALAPON [1]

**K. P. Buchholtz [2]**

Rhizomes were obtained from infestations of quackgrass in a number of localities in Wisconsin in 1955. Plants derived from single rhizomes were planted in isolated blocks in the field in 1956. In the fall of 1957 samples of rhizomes were obtained from 14 selected clones. The rhizomes were planted in pans in the greenhouse. After the plants were established the pans were treated with dalapon at the rate of 0, 1, 2, 4, and 8 lb/A. The



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dalapon was applied to the soil in sufficient water to ensure leaching. One week after treatment the foliage was removed from the quackgrass and the soil in each pan was inverted to force new shoot growth. Shoot numbers were determined 19, 28 and 42 days after treatment. Dry shoot weights were obtained after 42 days.

Since the clones varied in the number of shoots and dry weights produced by the material in the untreated pans, results were expressed as percent of check. Data on dry shoot weights appeared to be most meaningful. Dry shoot weight 42 days after treatment varied from 6 to 71 percent of the respective untreated check. The differences were highly significant. In some instances clones collected from the same location varied in sensitivity to dalapon but in other instances this was not true.

The number of shoots produced by the clones of quackgrass after treatment was also found to vary significantly. After 28 days it was found that the shoots of quackgrass in pans treated with 8 lb/A of dalapon varied from 3 to 160 percent of the shoot numbers in pans that were not treated. Shoot number increased with the longer time intervals after treatment. After 28 days a number of the clones produced more shoots in the treated pans than were obtained on the untreated pans. This was most pronounced at the lower rates of application.

The data indicate that quackgrass infestations are made up of clones that vary significantly in their sensitivity to dalapon. At times clones varying in sensitivity may be growing at a mixed population in a single location. Studies on responses of quackgrass to dalapon, and perhaps to other herbicides, may vary sharply from those obtained in extensive field use if the clone(s) selected for study differ from those prevalent in areas treated. It appears desirable to select clones that are known to be at least moderately tolerant of dalapon when making detailed studies involving the response of quackgrass to this chemical.

[1] Contribution from the Wis. Agr. Exp. Sta. as a collaborator under North Central Reg. Coop. Res. Proj. "Eradication or Control of Weeds and Other Undesirable Plants."

[2] Dept. of Agronomy, Univ. of Wisconsin, Madison.

## RESIDUAL HERBICIDAL ACTIVITY OF SOME CHLORO-SUBSTITUTED BENZOIC ACIDS IN SOIL [1]

**W. M. Phillips [2]**

Midland grain sorghum was planted in the spring of 1957 on plots previously treated with chloro-substituted benzoic acid compounds. A normal stand emerged on all plots and the plants appeared to grow normally during the early part of the season. After heading the sorghum showed symptoms of injury and little or no grain was produced.

In order to determine further the residual herbicidal activity, soil samples were taken in January 1958, to a depth of 6 feet. Two chemicals were included. One was the sodium salt of a compound consisting of approximately 60% 2,3,6-trichlorobenzoic acid (2,3,6-TBA). The other chemical was an emulsifiable-oil formulation of polychlorobenzoic acid (PBA). Plots treated with 2,3,6-TBA at 15 and 30 lb/A on May 11, 1955, and October 18, 1955, 16 and 24 lb/A on November 13, 1956, and 16 lb/A on June 3, 1957, were sampled. Plots treated on November 13, 1956, with 24 lb/A of PBA also were sampled.

The soil cores were sectioned into 1 foot lengths and garden beans were planted as a test crop. Approximately 3 weeks after emergence the bean plants were cut at ground level, oven-dried, and weighed. There was no apparent difference in the bean plants grown on untreated soil regardless of the depth from which it was obtained. Soil from plots treated with 15 or 16 lb/A 2,3,6-TBA on May 11, 1955, October 18, 1955, and November 13, 1956, produced bean plants which were similar in size and appearance. The most pronounced chemical effect appeared on plants which grew in the second, third, and fourth feet of soil. Plants growing in the first foot of soil from all plots and in the fifth foot from plots treated May 11, 1955, were slightly affected. In no case was there indication of large amounts of chemical in the sixth foot of soil. Although applications of 16 lb/A of 2,3,6-TBA made June 3, 1957, caused a similar growth pattern, the overall toxicity of this treatment did not appear to be as serious as that caused by the earlier treatments.

Comparisons of the two rates of 2,3,6-TBA applied May 11, 1955, October 18, 1955, and November 13, 1956 showed that the 24 or the 30 lb/A rate resulted in an increase in the residual herbicidal activity in the soil, but otherwise the two rates caused similar reaction. Of the plots sampled, only those treated with 24 or 30 lb/A of 2,3,6-TBA retained sufficient residual toxicity to interfere with germination and emergence of the beans. Effects caused by other treatments were manifested in abnormal and reduced growth.

Beans grown on soil treated in November 1956 indicated that, at most depths, 16 lb/A of 2,3,6-TBA had a greater degree of herbicidal activity than 24 lb/A of PBA.

The similarity of weight and appearance of beans grown in soil treated on different dates with 16 lb/A of 2,3,6-TBA indicated that the length of time the chemical had been applied to the soil did not greatly affect the residual toxicity. Distribution of the toxicant appeared to be directly related to the amount of precipitation after treatment.

Except for September 1955, the period from January 1955 to March 1957 was very dry. Rains received in September 1955 caused moisture to penetrate the dry soil to a depth of about 3 feet. Following that time severe drought conditions prevailed until the spring of 1957. Thus chemicals applied prior to 1957 could not have been leached more than 1 to 3 feet below the surface. Precipitation in 1957 was sufficient to cause moisture penetration to approximately 6 feet.

[1] Cooperative investigations of the Crops Research Division, Agricultural Research Service, United States Department of Agriculture, and the Kansas Agricultural Experiment Station. Contribution No. 127 Ft. Hays Branch, Kansas Agricultural Experiment Station, Hays, Kansas.

[2] Research Agronomist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

## COMPETITION BY BROADLEAVED AND GRASSY WEEDS IN THE ESTABLISHMENT OF LEGUMES [1]

**E. B. Hollingsworth [2]**

Competition between plant species is a major factor in all phases of crop production. The establishment of forage legumes is no exception. The results for three years of field experiments have emphasized the importance of controlling both broadleaved and grassy weed species when establishing alfalfa, red clover and birdsfoot trefoil.

Differences in the weed population were obtained by using the amine salts of 4-(2,4-DB) and 2,4-D for the control of broadleaved weeds and the sodium salt of dalapon for the control of grasses. During the third year, hand-weeded plots were included in addition to the non-weeded check. The herbicides were applied four to six



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weeks after emergence of the crop. Yield data were obtained from a single clipping six to eight weeks later. The major broadleaved species were Pennsylvania smartweed, ragweed, pigweed and lambsquarters. The principal grasses were large crabgrass, barnyardgrass, giant and yellow foxtail, fall panicum and stinkgrass.

There was considerable variation in the amount of rainfall for 1956 and that for 1958. In 1956 the rainfall for the six month crop season was seven inches below the average while the rainfall for the same period in 1958 was 11 inches above the average. During 1958 there was a marked increase in the yield of broadleaved weeds in the plots containing red clover or alfalfa. This increase was not apparent in the plots of birdsfoot trefoil. In the same season, the grassy weeds showed a pronounced increase in the plots of red clover and birdsfoot trefoil but not in the alfalfa. In all instances the yield of legumes was greatly reduced with the increase in weed yields.

Data from the non-weeded plots of 1956 show the relative distribution of the various species where no control measure was applied. The broadleaved weeds were dominant, suppressing the development of the legumes and weedy grasses, and producing over 80 percent of the total check plot yield. The weed grasses and legumes each made up only 6 to 11 percent of the plot yield.

In 1958, hand-weeding permitted removal of essentially all competing vegetation without injury to the legumes. Total weed yields of 3½ to 4 tons per acre were reduced to 1 ton or less. The yield of red clover and alfalfa increased nearly 400 lb/A and birdsfoot trefoil yield increased about 700 lb/A for the single clipping. Evidently birdsfoot trefoil received more benefit from the release of competition than did red clover and alfalfa.

Treatments from the 1956 test illustrate typical response when either the broadleaved weeds or grassy weeds alone are controlled. An application of one pound per acre of 4-(2,4-DB) reduced the yield of broadleaved weeds two tons or more per acre and permitted an increase in grassy weeds of approximately one ton per acre. The rather large increase in grassy weeds is indicative of their suppression by the broadleaved species. Red clover, being more competitive, was able to show a 1400 lb/A yield increase in the presence of the uncontrolled grasses. Alfalfa and birdsfoot trefoil increased only 200 and 500 lb/A respectively. An application of two pounds per acre of dalapon eliminated the grassy weeds and somewhat reduced the growth of broadleaved species compared with those of the check. Crop yields were considerably less in the presence of the broadleaved weeds than they were with the uncontrolled grasses. This was jointly due to injury by the dalapon and to greater suppression by the broadleaved weeds. Red clover was the most severely damaged with a yield of almost 500 lb/A less than that of the check. Alfalfa and birdsfoot trefoil were more tolerant of dalapon but were suppressed by the broadleaved weeds. They showed yield increases over the check of only 50 and 100 lb/A respectively.

When the yield of the crop is plotted against the total yield of weed species for the same treatment the relationship of the various points to an expected curve of response shows that dalapon, at the rate used, severely inhibited red clover but caused little or no damage to alfalfa and birdsfoot trefoil. Amine 2,4-D reduced the yield of red clover and alfalfa but did not have a noticeable effect on birdsfoot trefoil. Plots treated with 4-(2,4-DB) consistently produced higher yields than did other plots with the exception of those that were hand-weeded.

[1] Cooperative investigation between the Indiana Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

[2] Plant Physiologist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

## SOIL RESIDUE STUDIES WITH POLYCHLOROBENZOIC ACID [1]

**A. F. Wiese and H. E. Rea [2]**

Polychlorobenzoic acid (PBA) (30% trichloro-) has been used experimentally for eradication of perennial weeds since 1955, and in 1958 commercial preparations appeared in the market. However, very little is known about the period of soil sterility caused by the herbicides. In order to determine the residual period of PBA in the soil, wheat was planted in the fall of 1957 on plots previously treated for bindweed control. One of the plot sites was treated in November, 1955 and another in November, 1956. These plots were maintained under dry land conditions. A third area, in an irrigated wheat field, was treated March 1957. Under dry land conditions PBA was compared to monuron, fenuron, and erbon. Only silvex was compared to the PBA in the irrigated study. The rainfall for 1956 and 1957 was 13.3 and 22.5 inches, respectively.

The wheat yields from the dry land sites, Table 1, indicate that 20 lb/A of PBA was not toxic to wheat 1 year after treatment though the bindweed was eradicated. However, applications of 40 and 80 lb/A of PBA severely inhibited wheat growth for 2 years. Fenuron at 40 and monuron at 60 lb/A caused yield reductions for 2 years. Erbon at 80 and 160 lb/A neither eradicated bindweed nor reduced wheat yields. Erbon at 320 lb/A eradicated the bindweed and caused some wheat injury for 2 years.

**Table 1. Bindweed control and wheat yield in 1958 on dryland soil sterilant plots.**

| | | 1955 test | | 1956 test | |
|---|---|---|---|---|---|
| Sterilant | Pounds per acre | Pct control | Wheat bu/A | Pct control | Wheat bu/A |
| Check | 0 | 0 | 5.3 | 0 | 5.3 |
| PBA | 20 | — | — | 100 | 5.7 |
| PBA | 40 | 99 | 1.3 | 100 | 1.3 |
| PBA | 80 | 100 | 2.2 | 100 | 0.0 |
| Monuron | 60 | 29 | 2.9 | 84 | 0.0 |
| Fenuron | 40 | 93 | 2.9 | 95 | 0.0 |
| Feuron | 60 | 100 | 4.9 | 100 | 0.0 |
| Fenuron | 80 | 100 | 1.4 | 100 | 0.0 |
| Erbon | 80 | 49 | 3.8 | 67 | 7.1 |
| Erbon | 160 | 78 | 3.7 | 89 | 7.3 |
| Erbon | 320 | 100 | 2.9 | 94 | 0.0 |

In the irrigated study, Table 2, neither PBA nor silvex caused wheat injury when applied 6 months before wheat planting. Eradication of bindweed was obtained with 40 and 80 pounds per acre of PBA. Similar applications of silvex did not control the bindweed.

**Table 2. Bindweed control and wheat yields in 1958 on irrigated soil sterilant plots.**

| | Lb/A applied | | Control | Wheat |
|---|---|---|---|---|
| Sterilant | 3-22-57 | 10-30-57 | percent | bu/A |
| PBA | 10 | 0 | 4 | 34.3 |
| PBA | 10 | 10 | 99 | 2.1 |
| PBA | 20 | 0 | 74 | 26.3 |
| PBA | 20 | 20 | 100 | 3.6 |
| PBA | 40 | 0 | 100 | 36.1 |
| PBA | 80 | 0 | 100 | 22.7 |
| Silvex | 40 | 0 | 0 | 31.5 |
| Silvex | 40 | 40 | 100 | 26.3 |
| Silvex | 80 | 0 | 64 | 42.5 |
| Silvex | 80 | 80 | 100 | 26.9 |
| Check | 0 | 0 | 0 | 26.8 |
| LSD 5% | | | 26 | 7.2 |

Greenhouse studies indicated that PBA and silvex both severely reduce germination of wheat at 100 ppm concentration in the soil. Soybean germination was inhibited at 1 ppm by silvex and 10 ppm by PBA.



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In order to determine where the PBA was located in the soil profile by 1958, samples of soil were taken at various depths from each study, removed to the greenhouse, and planted to wheat and soybeans. In the dryland studies the PBA was primarily in the top 3 feet of soil in concentrations very toxic to soybeans, and somewhat toxic to wheat. In the irrigated test the PBA was concentrated below the top 2 feet of soil.

[1] Work conducted cooperatively between Texas Agricultural Experiment Station and the Western Soil and Water Management Research Branch, SWCRD, ARS, USDA. Approved as TAES T.A. 3071.

[2] Associate Agronomist at Bushland and Associate Professor at College Station, respectively.

## SOIL INCORPORATION OF SELECTIVE HERBICIDES

**J. Antognini, H. M. Day, R. Curtis, and G. F. Probandt** [1]

No abstract received.

[1] Stauffer Chemical Co., Mountain View, California

## PRELIMINARY RESULTS WITH 2,3,6-TRICHLOROPHENYLACETIC ACID FOR ERADICATING PERENNIAL WEEDS [1]

**A. F. Wiese and H. E. Rea** [2]

During 1957, a dimethylamine salt and an amide formulation of 2,3,6-trichlorophenylacetic acid were compared to other soil sterilants for eradication of field bindweed, Indian rushpea and Johnsongrass growing on Pullman silty clay loam soil. The chemicals were applied to field bindweed in August and November, to Johnsongrass in August, and Indian rushpea in November. The plot size was 1 square rod, and the experimental designs were duplicated randomized blocks. Data reported here were taken in September, 1958. The rainfall during the experimental period was approximately 22 inches. The sterilants compared with the 2,3,6-trichlorophenylacetic acid formulations were monuron, sodium chlorate, sodium tetraborate (Concentrated Borascu), dimethylamine salt of polychlorbenzoic acid (approximately 30% trichloro-) (PBA 30%), emulsifiable acid formulation of polychlorobenzoic (approximately 80% trichloro-) (PBA 80%) and fenuron. The rates of sterilant application and the percent control obtained are shown in Table 1.

The 2,3,6-trichlorophenylacetic acid formulations were very effective against the bindweed and Indian rushpea, but only moderately so against Johnsongrass. Bindweed was eradicated by 10 or more pounds per acre of the amine salt of 2,3,6-trichlorophenylacetic acid, 20 or more pounds per acre of the amide of 2,3,6-trichlorophenylacetic acid, and 20 pounds per acre of PBA 30%. Indian rushpea was eradicated by all rates of the 2,3,6-trichlorophenylacetic acid formulations except for the 5 pound rate of the amide. Twenty and 40 pounds per acre of PBA 30% and PBA 80% also eradicated the Indian rushpea. Johnsongrass was eradicated by 80 pounds per acre of amine salt of 2,3,6-trichlorophenylacetic acid.

The 2,3,6-trichlorophenylacetic acid formulations appear to have very little activity when applied to plant foliage. This characteristic was observed on bindweed, tansy mustard, wheat, sorghum and cotton.

**Table 1. Percent control of field bindweed, Indian rushpea and Johnsongrass with various soil sterilants.**

| Sterilant | Pounds per acre | Field bindweed Test 1 | Field bindweed Test 2 | Indian rushpea | Johnson grass |
|---|---|---|---|---|---|
| TPA* amine | 5 | 80 | 100 | 100 | 0 |
| TPA amine | 10 | 100 | 100 | 100 | 25 |
| TPA amine | 20 | 100 | 100 | 100 | 55 |
| TPA amine | 40 | 100 | 100 | 100 | 80 |
| TPA amine | 80 | 100 | 100 | 100 | 100 |
| TPA amide | 5 | 89 | 84 | 99 | 5 |
| TPA amide | 10 | 96 | 97 | 100 | 15 |
| TPA amide | 20 | 100 | 100 | 100 | 60 |
| TPA amide | 40 | 100 | 100 | 100 | 93 |
| TPA amide | 80 | 100 | 100 | 100 | 98 |
| Monuron | 60 | 95 | 68 | 94 | 20 |
| Sodium chlorate | 800 | 99 | 29 | 71 | 67 |
| Sodium tetraborate | 2560 | — | 87 | 82 | — |
| PBA 30% | 20 | — | 100 | 100 | — |
| PBA 30% | 40 | — | 97 | 100 | — |
| PBA 80% | 20 | — | 94 | 100 | — |
| PBA 80% | 40 | — | 97 | 100 | — |
| Fenuron | 40 | — | 94 | 92 | — |
| Fenuron | 80 | — | 97 | 95 | — |
| Check | 0 | 0 | 0 | 0 | 0 |

* 2,3,6-trichlorophenylacetic acid

[1] Work conducted cooperatively between Texas Agricultural Experiment Station and the Western Soil and Water Management Research Branch, SWCRD, ARS, USDA. Approved at TAES T.A. 3072.

[2] Associate Agronomist at Bushland and Associate Professor at College Station, Texas, respectively.

## CONTROL OF MUSK THISTLE WITH 2,4-D [1]

**J. F. Freeman** [2]

Musk or nodding thistle is a biennial weed which reproduces by seed. It occurs in pastures, meadows, and waste places in the northeastern and north central states to Missouri and in eastern Canada. It is not commonly found in Kentucky, but was established in Warren County in southwestern Kentucky more than 20 years ago. There it has become a serious problem on hundreds of farms and is gradually spreading into adjacent counties. Field plot experiments to study methods of controlling it with 2,4-D sprays were established near Bowling Green, the county seat, in the spring of 1956. The experimental area was located in a heavily infested pasture and had approximately 4 musk thistle plants/sq yd. Plots were 7x9 ft in size, arranged in a split-plot design with 4 replications. Main plots used as dates-of-treatment and sub-plots as types and rates of 2,4-D. Treatment dates and stages of development of older plants were (A) April 18, 1956—rosette, some plants 8-14 inches tall and beginning to elongate; (B) May 28, 1956—bud to early bloom; (C) September 6, 1956—6 inches or less in height; (D) October 17, 1956—12 inches tall. Seedling plants of various stages of development were present in plots at each treatment date. Main plots A and B were retreated April 29, 1957 at rosette stage, about 1 year after initial treatment of plot A. Sub-plot treatments with 2,4-D were with PGBE esters at ¼, ½ and 1 lb/A; the alkanolamine salt at ¾ and 1½ lb/A ;and an untreated check. The requisite total amount of 2,4-D formulation for the 4 replications of each sub-plot treatment was mixed with 4 pt water and 1 pt of the mixture was used for spraying each plot. This was equivalent to 62 gal/A. Spray treatments were applied with a hand-compression sprayer equipped with a single fan-type 8004 nozzle. Each plot was



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sprayed solidly 3 or more times to obtain uniform coverage of plants.

Stand counts of thistle plants on each sub-plot were taken October 17, 1956, April 29, 1957, and June 5, 1957. Percentage control of thistle plants based on the population of the untreated checks, for each date of counting is used as a measure of the effectiveness of various treatments with results shown in the table.

**Percentage control of musk thistle at 3 days following 2,4-D sprays applied at different times, and number of plants on untreated checks.**

| Type 2,4-D | Rate lb/A | Time of treatment: 4/8/56 4/29/57 — Date at which count was made: a[1] | b | c | 5/28/56 4/29/57 — a | b | c | 9/5/56 — a | b | c | 10/17/56 — a | b | c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PGBE ester | ¼ | 83 | 65 | 100 | 0 | 0 | 94 | 66 | 19 | 35 | * | 51 | 54 |
| PGBE ester | ½ | 76 | 63 | 100 | 0 | 0 | 96 | 70 | 47 | 54 | — | 93 | 95 |
| PGBE ester | 1 | 91 | 87 | 100 | 0 | 38 | 100 | 100 | 79 | 70 | — | 99 | 97 |
| Amine salt | ¾ | 92 | 64 | 99 | 0 | 0 | 97 | 96 | 89 | 90 | — | 88 | 88 |
| Amine salt | 1½ | 70 | 40 | 100 | 0 | 0 | 100 | 99 | 74 | 71 | — | 88 | 88 |
| Check | — | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | — | 0 | 0 |
| No. plants in 7 sq yd | — | 16 | 20 | 24 | 17 | 30 | 36 | 17 | 26 | 30 | 25 | 34 | 43 |

[1] Dates counted: a, 10/17/56; b, 4/29/57; c, 6/5/57. * Not treated until this date.

Musk thistle was not completely controlled by any of the 2,4-D treatments applied at either of the 4 dates in the first year. However, those made in mid-October resulted in good control—average for all rates, 84%, while those made in early September or in the preceding April were only fair—average 62 and 65%, respectively. Treatments made late in May were ineffective. Control was practically complete where April treatments were repeated in the second year, and was excellent on plots where the treatments of late May were repeated the following April. Emergence of seedling plants continued from early fall until late in the following spring and accounts for the progressively larger number of plants on the untreated checks at successive plant counting-dates. The September treatments and to a lesser extent the October ones were made prior to the emergence of many seedling plants, hence the poorer control of the earlier treatment dates. In general, the ester formulation of 2,4-D was more effective than was the amine salt. However, the lower rates of either were quite effective as a result of repeated applications made in April of successive years.

[1] This investigation is in connection with a project of the Kentucky Agricultural Experiment Station and is published by permission of the Director.

[2] Associate Agronomist, Kentucky Agricultural Experiment Station.

## STUDIES ON THE CONTROL OF WILD BUCKWHEAT

**D. E. Forsberg [1] and K. F. Best [2]**

Among the weed problems of Saskatchewan and other parts of the Prairie Provinces, wild buckwheat, in the classification "other weeds" in the Canada Seeds Act, has assumed increasing importance in recent years. This weed has become a problem because of its resistance to chemicals presently being used in weed control, and its twining habit of growth, which interferes with harvest and decreases yield of grain crops. Basic to the problems of developing more satisfactory methods of seeding habits and germination, development of the species as affected by climate or environmental conditions, and its reaction to herbicides.

Weed seed population studies entail the periodic sampling of soil to the depth of cultivation to determine the number of viable seed present in the soil and also to study the rate of build-up within that particular soil. Results indicate that in one summer-fallow period the wild buckwheat cannot be grown out of the soil, indicating a period of dormancy in the seed. In a stubble crop, in which the infestation of wild buckwheat is fairly heavy, an average seed build-up in the soil of 300 percent or more can be expected.

For longevity and depth of seeding studies, an area 3 feet by 6 feet was selected in which 1000 seeds were planted at 18 predetermined levels. Results from this test indicate that the majority of the buckwheat seed in the soil will germinate and emerge from depths down to 4 inches.

Germination takes place in all months from May to September. However, the largest percentage of germination is in May and the first week of June.

In life history studies it has been found that buckwheat starts flowering late in June and continues to flower until fall. The first flowers appear at the base of the leaf petioles and by mid-summer, short, upper branches develop which are thickly covered with flowers and seed. Consequently, each individual plant can produce flowers and seed on practically all above ground stems. One healthy plant of wild buckwheat is capable of producing in the neighborhood of 4,500 seeds in one growing season.

Two natural parasites have been found to attack wild buckwheat. The first is a small beetle called *Gastrophysa polygoni* which feeds on the leaves of this weed. Another parasite is floral smut (*Ustilago anomala* Kunze.) which affects all seed pods on an individual plant when present.

In studies on wild buckwheat seed germination a dormant period has been found to exist. Consequently, attempts to break this dormancy have been under study. By the removal of the pericarp germination was induced and further germination resulted by the puncturing or sectioning of the achene. The use of gibrel, indolacetic acid or potassium nitrate hastened germination as well as increased germination. Cold treatments indicated that they might give the same effect as sectioning or dehulling seed.

While these studies are going on we are still faced with the problem of controlling the weed. Considerable screening of herbicides has been done, and it should continue as new herbicides are formulated. Based on all tests in western Canada, we can safely say that wild buckwheat should be sprayed at an early stage, with an ester of 2,4-D. Best results are obtained if two 5 oz/A applications are made one week apart with the first going on at this early stage.

These studies have revealed several facts:

1. Wild buckwheat starts germinating early in May and continues to germinate throughout the growing season with the largest percentage germinating in May.
2. Most of the wild buckwheat will emerge from depths down to 3½ inches with some of the healthier plants emerging from as far down as the 6 inch depth.
3. A single plant is able to propagate tremendously in one year. Flowering commences in the latter part of June and continues throughout the season with flowers appearing on nearly all above ground stems.
5. Wild buckwheat seed possesses a dormancy period.
5. Wild buckwheat is resistant to most herbicides on the market today.

[1] Agronomist, Dominion Experimental Farm, Scott, Saskatchewan, Canada.

[2] Weed Investigations, Dominion Experimental Farm, Swift Current, Saskatchewan, Canada.



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## WEATHER EFFECTS ON PRE-EMERGENCE APPLICATIONS OF CDAA AND SIMAZIN

**Lyle A. Derscheid**

Pre-emergence spray applications of CDAA were made to corn at Brookings, South Dakota, on May 29, 1956 at rates of 4, 6, and 8 lb/A; to corn, soybeans and sorghum May 24, 1957 at 3, 4, and 6 lb/A and to corn and soybeans May 14, 1958 at 4 and 6 lb/A. Granular CDAA was applied to corn and soybeans the last two years at 6 lb/A in 1957 and 4 and 6 pounds in 1958. EPTC spray was applied to corn and soybeans at 2.5 and 5 lb/A in 1957 and 4 and 6 lb/A in 1958. Granular EPTC was applied at similar rates in 1958. Simazin was applied to corn, soybeans and sorghum at 1, 2, and 4 lb/A in 1957 and to soybeans and corn at 2, 3, and 4 lb/A in 1958. All of these applications were made as over-all treatments the day that the crops were planted. None of the chemicals were incorporated into the soil, which has a loam texture.

Simazin, CDAA and EPTC sprays were also applied to corn at Canton, South Dakota, on May 15, 1958 at the same rates used at Brookings in 1958, except that the 4-pound rate of simazin was omitted.

All spray applications were made in 12½ gallons of spray per acre in 1956 and 1957 and in 20 gallons in 1958.

Weather conditions for the various experiments varied considerably. In 1956, there was 0.97 inch of rain during the two weeks preceding treatment, 1.90 inches the first two weeks after treatment and 2.16 inches the second two weeks after treatment. Average maximum and minimum temperatures for the same periods were 72 and 47, 83 and 49, and 87 and 51 degrees. Rainfall, for the same periods before and after treatment, in 1957 was 3.95 inches, 5.93 inches, and 1.10 inches, and temperatures were 58-41, 75-46, and 75-53 degrees. Similar data for Brookings in 1958 were 0.10, 0.06 and 2.29 inches of rainfall and 74-40, 77-42 and 79-47 degrees. Weather data were not kept at the Canton field, but the temperatures were similar to those at Brookings in 1958, and the rainfall similar in the first two periods, but lower during the third period. Rainfall 10 miles away was .04, 0.93 in six showers and 0.71 in seven showers. The soil was wet at time of treatment in 1957, but dry for all other applications.

In 1956 all three rates of CDAA (4, 6, and 8) gave 100 percent elimination of foxtails for two or three weeks. Any weeds that emerged later were not affected. In 1957 temperatures were lower and rainfall higher prior to treatment and no weeds were killed with 3-, 4-, or 6-pound rates of CDAA. In 1958 the temperatures were similar to those in 1956, but rainfall was lower and 25 to 50 percent of the foxtail was killed in both experiments. The residual effect lasted about six weeks, however. Six pounds of granular CDAA, however, gave 100 percent kill in 1957 and zero control in 1958.

Although soil temperature was not measured, it is reasonable to expect that soil temperature was several degrees lower in 1957 than in 1956 or at either location in 1958 because air temperature was lower and rainfall higher. It appears that cool, moist soil at time of treatment may cause CDAA sprays to be less effective, but the reverse might be true for granular CDAA. The difference in results for 1956 and 1958, when weather conditions before treatment and at time of treatment were similar, might be explained by the different amounts of rainfall received after treatment. The 1.25 inches during the first week and the 0.65 inch during the second week of 1956 may have been enough to leach the chemical into the soil so that full herbicidal effect was obtained; whereas, the 0.06 inch during the two weeks after treatment in 1958 may not have been enough to leach the chemical into the soil where full herbicidal effect could be exerted at one time. This would explain the poorer kill but longer residual effect in 1958. This difference in rainfall after treatment may also account for the differences received with granular CDAA in 1957 and 1958. The higher amount received in 1957 may have aided the chemical; whereas, the low amount received in 1958 did not.

Weather conditions before or at time of treatment did not appear to influence the effectiveness of simazin. A 2-pound rate gave 60 percent kill of foxtails when applied to cool moist soil in 1957 and 75 to 85 percent kill when applied to warm dry soil at Brookings in 1958. Likewise a 4-pound rate killed 90 percent in the first test and 95 percent in the second.

The amount of rainfall after treatment appeared to influence the results obtained with simazin, however. When 1.25 inches fell during the first week after treatment in 1957, the 60 and 90 percent kills with 2- and 4-pound rates were obtained in two weeks; whereas, the 90 and 95 percent kills obtained in 1958 were not obtained for over a month when 0.06 inch of rain fell during the first two weeks after treatment and 1.50 inches fell during the third week and 0.79 during the fourth. Quicker kills obtained in 1957 may have been due to the leaching of the chemical into the soil or to earlier germination of the weeds. The former possibility seems to be the more logical because some weeds emerged uninjured during the third week after treatment in 1957. The 2- and 3-pound rates gave 21 and 17 percent elimination at Canton in 1958 compared to 75 to 85 and 80 to 85 at Brookings. The dry weather lasted for 15 days after treatment at Brookings and for over a month at Canton, indicating that the amount of rainfall after treatment may have influenced the results.

The weed kill was completely unsatisfactory on all plots treated with EPTC. Results might have been different if the chemical had been incorporated into the soil.

## EFFECTIVENESS OF THE ROTARY HOE FOR WEED CONTROL IN SOYBEANS [1]

**Walter G. Lovely, Charles R. Weber and David W. Staniforth [2]**

The effectiveness of the rotary hoe as a shallow cultivation implement for control of annual weeds in soybeans was investigated over a 3-year period. Various combinations of timely and untimely rotary hoe and cultivation operations were tested under different soil moisture conditions. Both row-planted and solid-seeded soybeans were utilized. Weed infestations were supplemented by seedings of green foxtail. Dry matter yield of above ground plant parts of mature weeds, together with seed yield, plant height, maturity and lodging of soybeans were obtained.

Timely and repeated rotary hoeings consistently reduced annual weed infestations 70 to 80 percent, and resulted in bean yields which approximated those from weed-free plantings. Delaying rotary hoe treatments until weeds had emerged, impaired weed control and reduced bean yields, compared with timely use of the rotary hoe. Moderately wet soil conditions at the time of, or shortly after rotary hoeing, also reduced the effectiveness of the implement. In row-planted soybeans impairment of rotary hoe effectiveness was partially offset by the weed control obtained with subsequent cultivations. Heaviest weed growth slightly delayed soybean maturity and increased lodging 10 to 15 percent.

[1] Joint contribution from the Iowa Agr. Exp. Sta., Ames, Iowa, and Agr. Eng. and Crops Research Divisions, A.R.S., U.S.D.A., Journal paper No. 3342 Iowa Agr. Exp. Sta., Ames, Iowa. Project 1121. This study was supported in part by a grant-in-aid from the National Soybean Processors Association.

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## PROGRESS REPORT ON THE BENZOIC ACIDS IN NEBRASKA

**Russel L. Nash** [1]

I must emphasize that this is not a research paper but a general summary of our benzoic acid work over the past three years, primarily concerned with perennial weed control.

We in Nebraska are very enthusiastic over the results obtained with the chlorinated benzoic acids. Our initial work began back in 1954 or 1955. At first the benzoics were tried primarily as pre-emergence herbicides and also at low rates on annual and perennial weeds. Neither of these proved to be too popular although varying degrees of weed control were attained.

Then it was reported that these compounds were working at higher rates as soil sterilants. So we started testing them at rates from 5 to 100 lb/A for control of perennial weeds. Somewhere along the line we have treated about all of the different serious perennial weeds that we have in Nebraska. We have treated field bindweed, Canada thistle, leafy spurge, bur ragweed, hoary cress, Russian knapweed, tanweed and I suspect there are others.

Field bindweed, Canada thistle, Russian knapweed and bur ragweed appear to be killed quite readily by these compounds. Leafy spurge and hoary cress appear to be somewhat more resistant while tanweed is apparently very resistant.

Apparently, there is little difference in effectiveness of these materials regarding time of application. When a soil application is made, whether early in the spring, midsummer or late fall. we have obtained satisfactory results. There is an indication that lower rates can be used when applied to the foliage.

We have used a number of different formulations of these benzoic acids. Our experience indicates that the 2,3,6-trichlorobenzoic acid is the most effective material when comparing various formulations at the same rates. The polychlorobenzoic acid (11.4% dichloro, 29.2% trichloro, 53.2% tetrachloro and 3.9% pentachloro) appears to be as effective as the trichloro when aproximately twice as much is used. Pricewise they compare quite closely. These two formulations are now available commercially in Nebraska.

Our recommendations for field bindweed, Canada thistle, Russian knapweed and bur ragweed call for 16 to 20 lb/A of 2,3,6-trichloro and 32 to 40 lb/A of the polychloro. We are undecided about hoary cress and leafy spurge.

At the present prices, these materials can be purchased for around $80 to $100 per acre which is competitive with some of the older soil sterilants.

What about residual effect? To date, indications are that we can expect to lose one crop for sure on areas treated with the chlorinated benzoic acids. However, I think we can safely say that during the second season the soil will support plant growth and in most cases some sort of a crop can be expected. Grass crops appear to be quite resistant to these materials and in most cases our grassy weeds are the first to come back in treated areas.

We have successfully taken Canada thistle and field bindweed out of Kentucky bluegrass without apparent injury to the bluegrass. This to me would be an important item in areas where these weeds are a problem in lawns or in areas where sodding is a common practice and used for landscaping purposes. Western wheatgrass and many other pasture grasses will tolerate considerable amounts of the compounds. Perhaps an exception to this is in Wisconsin where we read about Ken Buchholtz and his associates killing quackgrass with the benzoic acids. In western Nebraska, Russian knapweed has been knocked out of bromegrass at rates of 15 to 20 lb/A.

In spite of all the good results we have had in Nebraska, we still have difficulty getting farmers to use these materials or any other soil sterilants. The big reason perhaps is cost. We do not have a cost-sharing program of any kind for weed control in our state. You can persuade a farmer to use a material where he will be partially reimbursed but to persuade him on facts alone is a difficult problem, even when the facts point out that it is much cheaper to eradicate these small patches of noxious weeds than it is to keep them.

Regardless of this fact, I must say that a large amount of soil sterilants are being used and I must commend those who have had the foresight to go ahead and spend a little money to protect the future productivity of their land.

These benzoic acids, I am sure, are going to receive more widespread distribution in Nebraska in the future. Due to their consistent results, short residual effects, low toxicity and volatility, ease of application, and comparatively low price, I do not see how they can help but be a major soil sterilant for perennial weed control. Of course, there is the possibility that new and better chemicals will replace even them before they become widely used.

[1] Chief, Weed and Seed Division, Nebraska Department of Agriculture and Inspection

## THE USE OF INVERT EMULSIONS TO REDUCE SPRAY DRIFT AND INCREASE DEPOSIT OF HERBICIDES

**J. H. Davidson and L. L. Coulter** [1]

The safe use of plant growth regulator type herbicides around sensitive crop plants requires complete control of the spray. Small quantities of the spray contacting desired crop or ornamental plants can cause considerable damage. This problem has been encountered by growers treating their crops with 2,4-D for weeds and the custom spray applicator controlling weeds along highway or utility rights-of-way. Low volatile esters and amine salts of 2,4-D and 2,4,5-T have been formulated to reduce vapor drift hazards. A recent and improved method of controlling the spray has been the use of inverted emusions[2] carrying non-volatile forms of the toxicant. This combination has permitted the application of 2,4,5-T in close proximity to tomato fields with little or no evidence of injury.

The problem of crop damage due to 2,4-D and 2,4,5-T sprays has become of increasing importance. Growers of tomatoes, grapes, pears and other sensitive crops frequently complain of 2,4-D injury. Many believe the 2,4-D and 2,4,5-T in any form are unsafe for use in such areas, yet it is generally recognized that these materials are the most economical and effective weed killers available. This presents difficulty because corn is frequently grown in nearby areas and requires 2,4-D sprays for weed control. In addition, the economical control of vegetation on highway, railroad and public utility rights-of-way in such areas requires the use of herbicides. The formulation of herbicide sprays in a manner to eliminate volatility of the toxicant and reduce spray drift to a minimum warranted investigation.

Considerable work in the past has shown that certain forms of 2,4-D and 2,4,5-T are less volatile than others. One of the least volatile forms of these herbicides is the parent acid. Formulations using 2,4,5-T acid were therefore developed for this use.

With a non-volatile form of the toxicant, the next problem was to have a form of spray which could be applied with few or no fine particles to be carried by the wind as spray drift. Coventional emulsions of oil dispersed in water give spray characteristics similar to either oil or water alone. Fine particles of spray are generally present to be carried by wind for a considerable distance.

Inverted emulsions where the oil is the continuous

phase and water the dispersed phase give spray mixtures of entirely different consistency. By varying the ratio of oil to water, it is possible to obtain a spray consistency that will perform satisfactorily in conventional spray equipment yet be almost entirely free of spray drift.

A preliminary small scale field test to determine the possible reduction in spray drift was conducted using an air blast sprayer and tomato plants to serve as an indicator of spray drift. An air blast sprayer was used in this test because it was thought that severe drift conditions would be more certain to occur with this type of equipment. The sprayer nozzles were set to throw a spray out from the truck for a distance of 50 feet. Tomato plants to indicate 2,4-D drift were distributed at five-foot intervals out from the sprayer covering a distance of 40 to 230 feet from the sprayer. An air blast sprayer using a guage pressure at the pump of 350 psi passed perpendicular to the row of tomato indicator plants at a speed of one mile per hour applying a diluted spray of inverted emulsion with 2,4-D. Observations made on the tomatoes 10 days later indicated all the tomato plants between the distance of 40 to 65 feet showed severe 2,4-D symptoms. Beyond 75 feet, there were no visible 2,4-D symptoms, indicating that spray drift had been effectively controlled. It was concluded from this test that sprays of 2,4-D in invert emulsions reduced spray drift under adverse conditions.

After this encouraging preliminary field trial, a full scale test in the tomato growing area of Northern Illinois was conducted during the summer of 1958. 2,4,5-T acid in oil was applied as an invert emulsion on a highway roadside. The spray was applied using the equipment employed by a custom spray applicator for highway roadside spraying in the area. Two hand guns equipped with nozzles giving a flat pattern of spray were used on short lengths of hose to distribute the spray. This was done carefully to avoid directing the spray towards the tomato plantings. In addition, an overhead boom arrangement was tried and appeared to be a successful method of application. In both cases, spray pressure was reduced to about 200 psi. The rest of the equipment was used in a normal manner.

The section of highway sprayed was bounded on both sides by tomato plantings. Spray was applied May 26, after the newly set tomato plants were established and growing. At the time of spraying, there was a cross wind of approximately 10 to 15 miles per hour.

Observations made periodically during the summer indicated that there had been no spray drift at the time of application. Tomato plants growing 5 to 400 feet away from the sprayed roadside showed no harmful effects. Tomato foliage was in good condition, and there was no reduction in yield or quality of tomatoes from the plants near the sprayed area.

Another quality of invert emulsion sprays is their ability to build up a heavier deposit. Continued spraying on a given area results in a spray layer ¼ to ⅜ inch thick. This property of invert emulsions to increase deposit may be used as a foliage and stem spray and as a basal spray for small woody plant stems. The advantages of increased deposit and its relationship to improved kill of many wody plant species needs further evaluation.

[1] The Dow Chemical Company, Midland, Michigan.

[2] L. L. Coulter—Inverton 245, Down to Earth, Vol. 14: No. 1. Summer, 1958.

## DAMAGE TO HORTICULTURAL CROPS FROM 2,4-D AND 2,4,5-T DRIFT AND VOLATILITY

**E. K. Alban** [1]

Weed and brush control formulations of 2,4-D and 2,4,5-T have become invaluable chemical tools for right-of-way maintenance for highway, power, and telephone lines, for the general farmer, and other similar uses. Proper use of these chemicals has resulted in tremendous savings in the control of unwanted vegetation. However, mis-use of these herbicides has resulted in an ever-increasing number of complaints from growers of horticultural crops.

While 2,4-D and 2,4,5-T damage to horticultural crops is not a new problem, there is definitely an increased interest in this subject. Certain basic concepts are necessary to an adequate understanding of this problem: (1) No horticultural crops are completely tolerant of 2,4-D and 2,4,5-T, if time of application or concentration are ignored; (2) Most horticultural crops can be damaged and many can be killed through exposure to these chemicals; (3) The actual extent of damage to a plant or planting is often very difficult to evaluate; and (4) The question of "Whose 2,4-D or 2,4,5-T caused the damage?" is frequently the most difficult one to answer.

Many people can cause damage to horticultural crops through the improper use of 2,4-D and 2,4,5-T. They include: the general farmer; urban and suburban home owners; custom operators who work for farm, industry, and other property owners; highway spraying; and power and telephone line spraying. While any of these groups may be responsible for damage, the tendency at the present time is to place the blame on the custom operator, highway, power, and telephone line right-of-way spraying.

Although 2,4-D and 2,4,5-T are saving the general public thousands of dollars each year in maintenance costs of highway, telephone, and power line rights-of-way, the general public reaction is unfavorable in relation to the blighted vegetation which often appears along our highways and utility lines. Garden clubs, conservation groups, nature lovers, and home owners all tend to reveal an "anti" attitude toward the use of these chemicals. These poor public relations tend to aggravate the problem of misuse of 2,4-D and 2,4,5-T as it affects horticultural crops. The Ohio Department of Highways has been doing a god job in attempting to inform the public about the job they are trying to do. It is essential that industry and public service groups work together to let the public know why these chemicals are being used and, more important, develop use patterns which will minimize these complaints.

Growers of horticultural crops have a legitimate claim against the misuse of 2,4-D and 2,4,5-T. Grape growers have experienced serious losses in yield and quality of grapes as well as some loss of plants. To mato growers have seen yield reductions, delayed maturity, and poorer grades of fruit following exposure of plants and propagating stock, as well as a longer growing period for plants damaged by these chemicals. Landscape plants have been killed or so seriously damaged that they have had to be replaced. Practically all horticultural crop plants, at one time or another, during the past twelve years have revealed damage following the misuse of these chemicals. The Ohio Agricultural Experiment Station has been concerned with this problem and has carried out a program of studying the effects of these chemicals on many horticultural crops, as well as following through on the many crops accidentally subjected to spray drift or volatility hazards under Ohio conditions. A minimum summary of this research would indicate that there are no horticultural crops which are measurably improved through the chance exposure to 2,4-D or 2,4,5-T.

There is considerable discussion in regard to volatility, drift, safe distance to spray, formulation, and how can we minimize damage when we use 2,4-D and 2,4,5-T? The answer to these questions, for the most part, is academic. The practical answers are simply that: (1) millions of acres of crop land and non-crop land can be safely sprayed with 2,4-D and 2,4,5-T if the operator knows how and when to use these chemicals; (2) in problem areas, the spray rig operator should increase the volume of water used, increase the nozzle opening size, decrease the pressure, decrease the speed, and use the



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least volatile formulations (LV esters and amine salts); (3) everything must be done to educate users of 2,4-D and 2,4,5-T to the safe handling of these compounds; (4) we must realize that there are some areas where the use of these chemicals constitutes too great a hazard to adjacent crops to warrant their use; (5) better formulations, better methods of application, different seasons of the year, etc. must be developed and utilized if these chemicals are to be used in these hazard areas; and (6) safer chemicals or mechanical control of unwanted vegetation should be practiced in these areas of concentrated susceptible crops.

Chemical control of weeds and brush represents one of the great advances of the twentieth century. Continued acceptance and future development of this new science and industry would definitely seem to hinge on improved public relations and greater emphasis on consumer education in the safe use of 2,4-D and 2,4,5-T.

[1] Dept. of Horticulture, Ohio Agr. Exp. Station and Ohio State University, H.&F. Bldg., Columbus 10, Ohio.

## THE NECESSITY FOR VEGETATION CONTROL ON AMERICAN RAILROADS

**Cleston G. Parris** [1]

Class 1 railroads operated approximately 219,800 miles of railway line in the United States on December 31, 1957, of which 95,492 miles were in the 14 states included in the North Central Weed Control Conference area. This represents the total point-to-point length of the various railways in the country. It does not include the mileage of yard tracks or sidings, nor reflect the fact that a mile of railway may include two, three or more parallel tracks. The total miles of track operated by all line-haul railways including main tracks, yard tracks, sidings and tracks operated jointly with other railways amounted to about 288,600 miles at the end of 1957. Of this total about 96 percent was operated by the Class 1 railways.

The average width of railroad right-of-way is estimated to be approximately 125 ft which is equivalent to 15.15 acres per mile. This would mean that the American railroads maintain approximately 3,330,000 acres of right-of-way. Only a small fraction of this acreage is treated with chemicals annually yet railroads spend many thousands of dollars for controlling weeds and brush along their rights-of-way. It is estimated that approximately $20 million is expended annually for chemical methods of controlling vegetation on railroad rights-of-way in the United States and Canada, with an additional $10 million for mechanical methods of vegetation control. The savings resulting from weed and brush control practices may well exceed the expenditures for their control.

The question, "Why is it necessary to control vegetation on railroad rights-of-way?" has been asked often during recent years. There are a number of areas in which railroads are required to maintain good vegetation control. Among the most important are the elimination of all vegetation in the ballast area on main and branch lines, and controlling brush under communication lines. Good vegetation control practices are necessary in yard areas, station grounds, around bridges, trestles, communication poles, switch stands, signals, buildings road crossings right-of-way fences and, in some areas, maintaining fire breaks.

**Main lines.** The most important reason for controlling vegetation on main lines is to prevent fouling of the ballast. Vegetative growth catches and holds dust, dirt and other foreign matter, and, with subsequent decay, fills the ballast with foul material. When the ballast becomes dirty and clogged it impairs drainage which results in a loosening and churning action of the joint ties. This causes rough track which requires additional maintenance labor plus more frequent cleaning or renewal of the ballast. It is estimated that the average life of gravel ballast under normal conditions is five years and eight years for fully crushed aggregates. The cost of reballasting with gravel is approximately $3,900 per mile or an average yearly cost of $780 per mile. With totally crushed aggregates the total cost amounts to $5,000 per mile and over an eight year period this shows an average cost of $625. Assuming that good weed control practices extended the life of gravel ballast one year and crushed aggregates two years, it would reduce the average annual cost to $650 and $500 respectively. This would represent a saving of $130 or $125 per mile per year. Assuming further that the cost of chemical vegetation control is $65 per mile the total savings each year would be $65 and $60 per mile for gravel and crushed aggregate ballast respectively.

Keeping a roadbed free of weeds reduces the labor cost for normal maintenance. It is difficult to estimate the savings in labor. However, if good vegetation control practices resulted in one percent saving of the $400 million charged to track laying and labor accounts it would mean saving of $4 million in labor annually.

**Branch lines.** One of the most important reasons for controlling vegetation on branch lines is to prevent locomotive slippage. Vegetation is usually quite dense and rank on these lines. When it is blown or falls across the railroad it results in slippage of the locomotive. It is sometimes necessary for a train loaded to capacity to cut the train and set out a portion of their load. It may require an extra train in some areas to pick up these cars or it may result in delaying delivery of the commodity, each of which could be expensive.

**Yard areas.** The objective of yard weed control is to improve working conditions and prevent possible injury as a result of heavy vegetative growth. The problems involved in controlling vegetation in yards are about the same as those for the track roadbed. In addition, fire hazards may be more serious since railroad and industrial buildings are involved.

**Communication lines.** An important area in which vegetation must be controlled is the control of brush under communication and power lines to avoid voltage leaks. Other areas are those locations where visibility must be improved.

**Special areas.** It is necessary to maintain vegetation control around bridges, trestles, buildings and communication poles primarily for fire protection. It is reported that $1 million is spent annually for repairing bridges damaged by fires. Individual bridge fires, not reported as such, amount to $1 to $2 million. This includes cost of delays, tie-ups and rerouting. To replace a bridge or trestle costs approximately $100 per linear foot. To replace a 35 ft communication pole it costs approximately $150. Considering the cost of replacing these items, good vegetation practices may result in a substantial savings if they prevent damage from fires.

There are a number of minor reasons why it is necessary to control vegetation on railroad rights-of-way, and these may be listed as benefits. Among these are to increase the life of track materials. The accumulation of vegetation in tight pockets against metal structures in humid atmosphere can contribute to a phenomenon called crevice corrosion. Also an abundance of vegetation may hinder inspection of track and increase labor cost of replacing cross ties. The added cost of replacing a tie where vegetation is heavy appears small for each individual tie but the amount of labor required is 10 to 50 percent over that required where ballast is weed free.

Other reasons for controlling vegetation are to prevent snow drifts, to prevent the spread of noxious weeds and to improve appearance. These minor reasons for controlling vegetation may appear to have little value, however, many benefits may be realized by railroads who practice good vegetation control.

It is interesting to note that the maintenance ratio



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to total operating revenue is decreasing due to improved technology and better methods of which weed control is one phase.

[1] Agronomist, Association of American Railroads, Chicago, Illinois.

## NEW APPROACH TO HERBICIDE SPRAYING

**John E. Waldrum** [1, 2]

As the use of herbicides has advanced, there has been an increasingly evident need for formulations which can decrease the hazards of spray drift and for materials with improved penetrating and marking qualities. For several years, Amchem Products, Inc. has been investigating a new and special type of material which seems to provide these characteristics—the inverted emulsions.

Basically, an invert emulsion is a water-in-oil mixture, with every spray droplet surrounded by oil instead of water. When these formulations are mixed with oil and water in various proportions, a viscous material similar to buttermilk or mayonnaise is produced.

At first, there was no practical method for comparing these materials with standard oil-water sprays because there was no equipment that could apply the more viscous inverts satisfactorily. Therefore I, as a member of Amchem's engineering group, was asked to help cope with the mechanical aspects of the problem.

The object of this presentation is to outline what I am trying to do, show briefly what I have done and ask for helpful comments and suggestions.

The first thing we needed was a machine which would satisfactorily handle both standard and very viscous materials. This would eliminate variables due to application technique. The thick invert emulsion could not be pumped satisfactorily nor would it disburse properly from a conventional spray nozzle. The most appropriate basic distribution principle I could think of was centrifugal force. Pursuing this idea, I put a worm in a two-inch pipe, placed a nine-inch disc at one end, drove the disc with the worm through a beveled gear and turned the worm with a one-horse power engine. The gadget was mounted on a truck like a boom with horizontal and vertical controls. The material was gravity-fed to the worm from a drum. The worm conveyed the material to the disc, which in turn threw it in a horizontal plane over the disc lip through a 360° circle. This rig discharged anything from water to mayonnaise quite well. It produced a uniform swath which could be varied from ten- to thirty-foot widths. The situation looked promising and we sprayed ground application plots with this machine.

The next step was to try this system from the air. I could only guess what would happen to the swath at high rates of speed. To get some idea as to what I was coping with, we loaded the rig, put it into operation and drove down the road at fifty miles per hour. The swath width was not affected by forward motion to a great extent, but the air currents had a tendency to scoop the material out of the open disc. With these meager facts at hand, I began work on a sprayer for a helicopter.

For this experiment, the equipment would have to be light and portable. I needed a small self-contained unit that would make a fifty-foot swath at forty miles per hour and deliver thirty gallons per minute. It had to be a closed disc to protect the distribution of material on the pan from air flow. The disc must operate below the skids of the helicopter to get away from the rotor blast and to avoid spraying the helicopter landing gear.

The resulting equipment was a twenty-gallon aluminum tank with a two-inch piece of aluminum tubing welded along its bottom and extended two feet to one side. Fastened to the outer end of this tube was a shallow pan-like disc with a cover on it which turned with the disc. This was driven by a one-half horsepower twenty-four volt motor, and was gravity-fed from the tube through the axis of the cover. This machine was attached to the rear skid cross member of the helicopter by two pivot brackets.

This proved to be a functional piece of equipment, but the solid sheet of material flowing from between the pan and the cover broke into droplets of varying size indicating the necessity for a better method of controlling droplet size. Also, it was obvious that there had to be a sharp cutoff system in the disc itself.

The disc section was redesigned by sealing the top to the bottom and placing around its circumference ports through which the material could escape. Varying the dimension and number of the openings would control volume and particle size. A multi-valve assembly was placed inside the disc and actuated by a pivot mechanism at its axis. This proved to be a very satisfactory system for aircraft.

The installation of this disc on the fixed wing airplane was somewhat more complicated. This was due to the higher air speeds and the take-off and landing characteristics. An "A" frame was designed to pivot on the running gear cross-members of a Stearman. A swivel joint was placed at the pivot axis of the "A" frame. A pipe in one end of the swivel led to the hopper, while the pipe in the other end passed down the center of the frame and terminated in the disc.

This assembly was actuated by a hand-operated hydraulic strut. This strut retracted the rig for landing and lowered it to a position below the wheels for spraying. This position also kept the material being sprayed out of the prop wash and the air currents caused by aircraft displacement. The disc was driven by a hydraulic motor powered from a pump on the aircraft engine. This was a very functional system but more complicated than necessary for future units.

The latest development in this centrifugal sprayer is the elimination of the boom on the ground equipment by using a disc which sprays through 180° instead of 360°. This development makes a simple compact unit which requires no manipulation. This will be used for field, farm, roadside and aquatic research work in 1959.

[1] Amchem Products, Inc., Ambler, Penna.

[2] To the people of Wiggins Airways in Norwood, Mass.; Aero Ag. Service in Alice, Texas; the R. E. A. in Lovingston, Virginia; the Game and Wild Life Commission of Louisiana; Chem-Air in Washington State; and last but not least, Mr. Harry Elwell of Oklahoma State University, who has done considerable research with this machine, I would like to express my personal and my company's appreciation for the contributions made to this project. With their assistance we have been able to test this equipment over a cross-section of the United States.

## A NEW CONCEPT OF BRUSH CONTROL USING A PELLETED MATERIAL [1]

**J. W. Herron** [2]

The majority of herbicides used in chemical brush control programs at the present time require water or oil and expensive spray equipment for application. Workers in all phases of weed control are constantly trying to find more effective chemicals and better methods of application.

More information is needed regarding the susceptibility of various woody plant species and application costs of pelleted herbicides. Plant species, soil types, rainfall, and types of root system may affect the rapid-

ity of response to soil applications of pelleted herbicides which are absorbed through the root system. Symptoms resulting from such treatments do not usually occur in woody plants until several weeks after applications are made.

Information reported in this paper is based on a joint study made by representatives of the University of Kentucky and the DuPont Company. Although these tests were started in the spring of 1958, results to date are such that it is felt a report at this time can be justified.

Applications of fenuron pellets were made on different areas at rates of 6, 8, 10, 12, 14, 16, and 18 lb/A on March 4, March 12, April 9, and June 21, 1958. Observations were made on October 16, 1958. The treatments made on March 4 were applied with a cyclone type hand-seeder. The remainder of the treatments were broadcast by hand over the entire area. The areas treated ranged in size from 400 sq ft to 21 sq ft. Trunk diameters of the majority of trees were less than six inches. There were also present a few stumps of recently cut trees with diameters ranging from 6 to 15 inches.

The effectiveness of the treatments cannot definitely be determined until next year. However, results from observations made on October 16, 1958 suggest that the use of fenuron pellets for general brush control is quite promising.

Unpublished data furnished by DuPont indicate that it required approximately one tenth the number of man-hours to treat with fenuron pellets as it did to treat a comparable area with basal spray applications of 2,4,5-T in oil.

Results to date indicate that the minimum rate of fenuron pellets required for general brush control is from 12 to 14 lb/A of active ingredient. Treatments in which higher rates were used did not appear to be more effective than the 14 lb/A rate. It was apparent that certain species were susceptible to fenuron at the rate of 6 lb/A. Treatments at the lower rates may prove to be more effective by the spring of 1959 than they appeared to be on October 16, 1958.

Applications made in March and April appeared to be much more effective by October 16, than those made in June. The leaves of some plants in the plots treated in June exhibited some chlorosis.

Species that appeared to be killed or severely injured as a result of applications of fenuron pellets at the rates of 12 to 18 pounds per acre were: white ash, hickory, oak, elm, mulberry, osage orange, red cedar, maple, poison ivy, and hackberry. Scattered plants of other species that appeared to be severely injured or killed by these treatments were: redbud, black locust and sassafras.

Carolina buckthorn appeared to be resistant to all early treatments, but showed slight chlorosis from applications made on June 21.

By October 16 ground cover of herbaceous plants was present on all treated plots, thus reducing the possibility of erosion.

Although additional information will be necessary before definite conclusions can be determined, results of these experiments suggest that the use of pelleted herbicides shows considerable promise as a method of brush control.

Primary advantages of using pelleted materials are:

1. Expensive equipment is not needed.
2. Water is not required for application.
3. Time required for application is considerably reduced.

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[1] Published with the approval of the Director of the Kentucky Agricultural Experiment Station.

[2] Department of Horticulture, University of Kentucky, Lexington, Ky.

## OBSERVATIONS ON DOMESTIC ANIMALS EXPOSED TO HERBICIDE SPRAY APPLICATIONS OF 2,4,D, 2,4,5-T AND DALAPON

**H. E. Goldstein, D.V.M. and J. F. Long, D.V.M.** [1]

With the increasing use of new chemical compounds in the field of agriculture during the past few years, it is natural that much thought has been given to possible toxic effects on livestock exposed to these new products. Included in the group are the newer herbicides such as 2,4-D, 2,4,5-T and dalapon. The extensive use of these materials by state and county highway departments as well as by farm operators themselves, have made the livestock industry cognizant of the products.

When a livestock owner observed sickness in his animals and the cause of the disease is not obvious to him, he often tends to think of toxic materials to which the animals may have been exposed. When recent spraying of the roadside or adjacent fields etc., has been done, he sometimes feels that the spray may have been the source of his difficulty. In a case such as this, it is of utmost importance that a thorough diagnostic examination be performed on the affected animals to determine the exact cause of death, for the benefit of the livestock owner as well as for the party involved in the spraying. At the Diagnostic Laboratory of the Ohio Department of Agriculture, Division of Animal Industry, we have had many cases brought to our attention in which the livestock owner was so sure that the herbicide spray was the cause of the trouble with his animals that he did not follow up with having diagnostic studies performed on his animals and unknowingly allowed an infectious disease such as hog cholera, erysipelas, Salmonella infections and other infectious diseases to take a heavy toll of his animals. From the standpoint of the organization conducting the spraying operation, it is important to have thorough diagnostic studies performed since many claims were paid on livestock losses where there was little investigation done to rule out infectious diseases. This was due to the fact that such facilities were not available at that time. Now, however with the widespread use of the facilities of the diagnostic laboratory, there is little reason for not having thorough diagnostic studies performed on any unexplained livestock losses.

The procedures which we follow at the laboratory in cases whereby a livestock owner believes that herbicidal sprays of 2,4-D or 2,4,5-T may have caused his losses is as follows. We instruct him to bring to the laboratory one or more of the animals which have recently died or are about to die. We then obtain a complete case history and then proceed with the post mortem examination and laboratory studies on the tissues. In over 90% of the cases submitted to the laboratory where 2,4-D or 2,4,5-T spray was suspected, we found definite evidence of bacterial, viral, or parasitic diseases as the real cause of the losses. In many other cases we found other materials to be involved such as lead poisoning, arsenic poisoning, or poisonous plants.

If the exposure was of an unusual nature or if an unusual plant species was sprayed and then consumed by the livestock we try to set up an experiment in which we attempt to duplicate the actual conditions which occurred in the field by using experimental animals of the same species and by exposing them to the sprays in similar fashion. We will now go over some of the experiments which we have performed.

When we go over these studies, in order to avoid giving the detailed concentrations used each time, we will mention now that when we refer to the recommended concentration of 2,4-D we will be referring to 3 quarts of concentrated solution per 100 gallons of water and when we say the recommended concentration of the 2,4-D, 2,4,5-T mixture we will be referring to 2 quarts of 2,4-D and 1 quart of 2,4-5-T per 100 gallons of



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water. We have adopted these concentrations in order to standarize the rates of exposure in our experiments.

Of course the most common situation which has been called to our attention from field cases is that in which a portion of a pasture gets accidently contaminated with drifting spray from a roadside or in which a pasture is purposely sprayed to eliminate certain undesired vegetation. Therefore, our first tests were set up to duplicate these conditions. We decided to perform separate experiments using 2 cattle in the first test, 6 sheep in the second test and 4 swine in the third test. We used the standard recommended levels of 2,4-D and 2,4,5-T. After allowing a period of time to elapse we sprayed the pasture lots again only this time we used twice the recommended concentrations. After observing the animals for an additional period of time we again sprayed the lots. This time we used 4 times the recommended concentration. We again observed the livestock and they did not develop any harmful effects at any time. By this time all the weeds and brush had been eliminated or consumed and the experiments were discontinued. We concluded that 2,4-D and 2,4,5-T spray on our pasture vegetation did not cause any visible toxic effects on cattle, sheep or swine.

The next most common situation is where livestock apparently were close enough to receive the spray drifting directly on their skin. Therefore, we have endeavored to duplicate this situation in calves, cattle, sheep and swine. A calf was sprayed with a pint of the recommended level of 2,4-D spray. It was observed and then sprayed with 2 quarts of 2,4-D spray. It did not show any harmful effects at any time. Likewise a cow sprayed with a half gallon of 2,4-D 2,4,5-T mixture showed no harmful effects. Sheep sprayed with a quart of 2,4-D 2,4,5-T mixture as well as with twice the recommended levels showed no harmful effects at any time. Similar experiments on swine using sows as well as young pigs showed no harmful effects. Thus we concluded that 2,4-D and 2,4,5-T sprays on the skin of our cattle, sheep and swine did not cause any visible toxic effects.

In the previously discussed research, we have dealt with situations whereby animals receive a more or less acute exposure to a large amount of spray for a comparatively short time. Now we will deal with situations whereby livestock could be exposed to small amounts of the materials over a long period of time, in other words—chronic exposures. In situations which have come to our attention from field cases this could be brought about by several different means. In one case a pond used as a water supply for some cattle was contaminated with roadside spray. The owner believed that the animals drinking this over a several weeks period could have caused his trouble. It would also be possible to receive a chronic exposure if some hay in a field were contaminated and then subsequently fed. In order to simulate this situation a test was set up whereby the hay fed to the animals was sprayed twice a day with 50 ml of 2,4-D and 2,4,5-T spray over a 41 day period. Simultaneously the animals were drinking water corresponding to ¼ pint of spray mixture per 5 gallon quantity. This was also continued over the 41 day period. The animals were observed daily throughout the period and did not show any visible harmful effects.

Regarding our present studies at the laboratory we are primarily interested in three types of problems. First, we are determining whether or not the herbicidal sprays will result in animals consuming plants which they normally do not consume. We are utilizing animals which are salt-hungry and animals which are salt-satisfied in an effort to see if this factor has any influence.

Secondly, we are determining whether or not certain plants can produce toxic substances during the wilting process such as producing toxic amounts of prussic acid or toxic amounts of nitrates. This will have to be worked out for a number of common plant species at various stages of growth. In our preliminary studies using Sudangrass pasture and oats pasture which were sprayed with dalapon, we did not detect any harmful effects in sheep and cattle.

Third, we are also conducting a series of experiments on dalapon in which we are exposing livestock to dalapon following the same pattern that we used for 2,4-D and 2,4,5-T. At the present time we have completed a test in which a pasture lot was sprayed with a very heavy concentration of dalapon, (30 lb. per 100 gallons of water). Two calves grazed the grass until it had all turned brown or had been consumed. The calves did not exhibit any harmful effects at any time.

**Conclusions.** In conclusion we would like to mention that at this time we have not detected any visible harmful efffects on cattle, sheep and swine from their being exposed to 2,4-D, 2,4,5-T sprays whether applied to the pasture, in the source of water, on their cut hay or on their skins.

[1] Diagnostic Laboratory, Ohio Department of Agriculture, Division of Animal Industry.

## ERADICATION OF WEEDS BY MINNESOTA FARMERS

**Sig. Bjerken** [1]

Minnesota consists of an area of approximately 51,000,000 acres, of which approximately 20,000,000 acres are cropland, and we have serious weed problems. People recognized this menace as early as 1872, and at that time passed what is known as the Canada thistle law. However, weeds continued to spread.

Although fortified by a weed law that permits us to bring about weed control on any tract of land in the state, control is generally brought about through personal contact and understanding between parties involved. By obtaining cooperation in this manner, along with an effective weed law, real progress can be made in weed control. Minnesota farmers generally have been quick to utilize new methods of weed control, and they have used effectively practically all the methods described in our 75-page research summary. However, it is interesting to review the present status of weed species in Minnesota.

**Canada thistle.** A perennial weed, still widespread throughout the state.

**Sowthistle.** A perennial plant, widespread in the Northwestern part of our state with scattered infestations in the remainder of the state.

**Austrian field cress.** A perennial weed and of a very serious nature. However, this weed has been practically eliminated in our state through the use of 2,4-D ester.

**Perennial peppergrass.** A perennial weed which has also been practically eliminated in our state through the use of chlorate compounds.

**Russian knapweed.** Another perennial weed which has been practically eliminated through the use of chlorate compounds.

**Poison ivy.** A perennial weed that is widespread in the eastern portion of our state.

**Leafy spurge.** A perennial plant that is most difficult to eliminate, being one of the most deeply rooted plants in existence, spreading rapidly by root and seed. Approximately 80% of the leafy spurge in Minnesota has been eradicated through following recommended practices.

**Field bindweed.** A perennial that was a real threat to agriculture a few years ago. However, through the use of 2,4-D, this threat has been largely eliminated and this weed is no longer to any extent a menace to Minnesota farmers.

**Cockleburs.** A real threat to soybean and corn raising farmers in our state.



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**Frenchweed.** An annual that is effectively being controlled by spraying with 2,4-D.

**Wild radish.** (Joint or white charlock.) One of the most serious species of the mustard family. Although an annual or a biennial, this weed is serious in that seeds do not shell out of the pod but rather the pods have joints at intervals the length of an oat kernel. They break off at these joints and are therefore difficult to clean out of grain. However this plant is susceptible to 2,4-D.

**Wild oats.** A real menace to the farmers of Northwestern Minnesota. Farmers who carry out a short fallow program, both in the spring and in the fall, and sow a delayed crop such as flax and barley, are getting good results.

**Sunflowers.** A weed which is spreading rapidly and now the farmers are aware of its seriousness.

**Giant foxtail.** A weed that is giving farmers much concern in Minnesota and must not be taken lightly. Especially, it is a real threat to the soybean grower.

**Hoary alyssum.** A plant that is classed both as an annual or a biennial and is spreading more rapidly than any other weed, especially in the Eastern half of the state. This weed has a tendency to thrive best in light soils; a real menace to farmers raising legumes.

**Quackgrass.** Widespread through the state, but many effective controls.

**Indian mallow.** (Velvet weed or buttonweed.) This is on the increase, especially is it serious in Southeastern Minnesota. This weed is a terrific seeder.

**Kochia.** Readily controlled by 2,4-D in grain.

**Cockle family.** Weeds that are giving farmers raising seed much concern. Rogueing seed crop of these pests is a practice carried out by farmers. To date chemicals are not too effective.

**Buttercup.** A weed that is a real threat to the dairy industry and is spreading rapidly in those areas.

**Orange hawkweed.** This is also a weed which is spreading rapidly in the Northeastern part of the state. This weed too, is a real menace to the dairy industry.

**Tansy.** A weed spreading throughout Northeastern Minnesota, which is mainly a pasture and non-crop problem.

Minnesota has some 6,500 state, county and local weed inspectors working with the people of our state. They assist our farmers in working out weed control measures in connection with their cropping programs prior to the planting season, assuring them that every acre of cropland may be cropped provided the proper crop is planted and the right chemical or method is applied. Such a program appeals to the average farmer of our state and his cooperation is generally forthcoming.

We have today the means to control weeds if we put them into practice.

[1] Minnesota Department of Agriculture.

## OBSERVATIONS ON PUBLIC LAW 518

**John T. Coyne** [1]

What is P. L. 518 or the Miller Pesticide Chemicals Amendment, as it is more popularly known? The Miller Amendment to the Federal Food, Drug, and Cosmetic Act was enacted as Public Law 518 of the 83rd Congress on and was signed by the president on July 22, 1954. This law created a new section in the Federal Food and Drug Act of 1938. The 1938 Act provided for setting tolerances or safe limits for residues of various additives to food. These chemical additives covered many types, including as examples coloring substances, preservatives and pesticide chemicals. The process of carrying out these provisions proved to be cumbersome and time consuming. P. L. 518 was enacted to establish more practical and speedier procedures for getting tolerances for a particular class of chemical additives, specifically pesticide chemicals.

What is a pesticide chemical as defined in P. L. 518? It is any material which is used in the production, storage or transporatation of food or feed crops to control insects, rodents, fungi, weeds and some forms of bacteria. Any residues of materials used for these purposes on food or feed crops must have a tolerance or exemption under P. L. 518 before the crops legally can be shipped interstate.

Who enforces P. L. 518? The Federal Food and Drug Administration has exclusive authority and responsibility for the enforcement of this law. The usual mode of enforcement is to sample and analyze interstate shipments of food and feed crops to be certain that they do not bear a pesticide chemical residue which is not covered by a tolerance or exemption, or a residue in excess of an established tolerance. If any of these conditions exist, the crop involved is in violation of the Act, and may be seized.

How does the U. S. Department of Agriculture get into the picture? While P. L. 518 does not charge the Department with any enforcement activities, it does assign two other specific responsibilities to the USDA. First, the law provides that before a tolerance or exemption can be set for any use of a pesticide chemical, the Department must certify that the chemical is useful for that purpose. This provision is a substitute for the previous requirement in the Food and Drug Act under which it has to be shown that the chemical was necessary in the production of the food in order to get a tolerance.

The second responsibility of the USDA is to express an opinion to the Food and Drug Administration as to the amount of residue likely to result from the proposed use of the chemical for which a tolerance is sought. In practice, a specimen label containing proposed directions for use is made a part of the petition submitted by the company. Copies of the petition are submitted to the Food and Drug Administration and the USDA. The Department reviews the directions for use in the specimen label and the residue data set forth in the petition or available from other sources. On the basis of the best information we are able to obtain, we determine whether or not to certify the chemical as useful, and form an opinion as to what residue is likely to result. This opinion is given to the Food and Drug Administration with the appropriate certification of usefulness.

After receipt of the certification of usefulness and the opinion on residue from the Department of Agriculture, the Food and Drug Administration begins to review the petition. Basically, this review must be completed within ninety days. It encompasses a study of the composition and toxicity of the chemical, the pattern of use, test results on the amounts of residue remaining, practical methods for removing excessive residues and the proposed tolerances. When a suitable tolerance or exemption has been determined, the Food and Drug Administration publishes an appropriate announcement in the Federal Register.

To summarize up to this point, P. L. 518 establishes procedures for setting tolerances or exemptions for agricultural chemicals used to control specified pests on food or feed crops shipped interstate. Tolerances or exemptions can be established only for those chemicals which the USDA certifies are useful in agriculture. The presence of a pesticide chemical residue on a crop, shipped interstate when there is no established tolerance or exemption or the presence of chemical residue on a crop in excess of an established tolerance makes that crop subject to seizure under the Federal Food, Drug, and Cosmetic Act.

Now we've discussed the Miller Amendment. However, there is another Federal Statute which we must consider if we are to have the whole picture. This is the Federal Insecticide, Fungicide, and Rodenticide Act. This law is administered by the Department of Agri-



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culture, and regulates the interstate marketing of economic poisons. Its purpose is to protect the users of economic poisons and the general public from physical injury or economic loss resulting from the purchase and use of these materials. This is accomplished by the requirement that proposed labeling and evidence to prove the safety and effectiveness of an economic poison must be submitted to the Secretary of Agriculture before shipment in interstate commerce. The proposed labeling and the evidence submitted are evaluated by the Department, and if found to comply with the Act, the product is registered. There is also an enforcement program under which samples of interstate shipments of these materials are selected, analyzed and tested to determine their compliance with the law. You will note that the Federal Insecticide, Fungicide, and Rodenticide Act regulates economic poisons, while Public Law 518 deals with pesticide chemicals. An economic poison is a completed formulation or finished product subject to the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act. A pesticide chemical is that element of the completed formulation which by itself is capable of controlling the insects, weeds or fungi. Residues of this element, or pesticide chemical, on food or feed crops require tolerances or exemptions under Public Law 518. So we see the two statutes are related. A grower uses an economic poison, which has been shipped interstate to control pests on food or feed crops. If that product is to comply with the law, its direction for use, warning statements and other labeling requirements, must have been accepted by the USDA under the Federal Insecticide, Fungicide, and Rodenticide Act, prior to shipment. Then if the use of this product leaves a residue of the active ingredient, the pesticide chemical on a food or feed crop, the Food and Drug Administration must have established a tolerance or exemption for the residue of the pesticide chemical on the crop before that crop can legally be shipped interstate.

To summarize once again, we have the Federal Insecticide, Fungicide, and Rodenticide Act, under which are registered many labels bearing directions for use of economic poisons on food or feed crops. These economic poisons contain pesticide chemicals which if present on a crop when introduced into interstate commerce, require a tolerance or exemption under Public Law 518.

It becomes apparent that a situation might result under which an economic poison might comply with one Federal Statute by virtue of having been accepted for registration under the Federal Insecticide, Fungicide, and Rodenticide Act, and yet its use might result in the violation of another Federal Statute, specifically Public Law 518, because it contains a pesticide chemical of which a residue is left on a food or feed crop and there is no tolerance or exemption for the use of the chemical on that crop; if there is a tolerance, the resulting residue exceeds the established tolerance. This is obviously an undesirable situation and one which is contrary to the legislative intent.

To mitigate this situation, USDA personnel have been pointing out to registrants which of their registered uses have not been proven to comply with P. L. 518. This has been done as part of the registration and enforcement programs in the administration of the Federal Insecticide, Fungicide, and Rodenticide Act. In this manner we have hoped to point out to registrants specifically where their trouble areas lie and to stimulate their efforts to get these uses cleared under P. L. 518. However, to be realistic, we must point out that there are still registered today under the Federal Insecticide, Fungicide, and Rodenticide Act, an appreciable number of pesticide chemical uses for which needed tolerances or exemptions have not been established. Perhaps some figures would illustrate the situation more specifically. There are approximately 4500 pesticide chemical uses registered under the Federal Insecticide Act for use on food or feed crops which potentially may result in residues on these crops. I emphasize the word potentially because not all registered uses of pesticide chemicals will result in residues of the chemical on the treated crops. When no residue results, neither a tolerance nor an exemption is required. Thus, the fact that a tolerance or exemption has not been established for a particular use does not mean that such use is automatically in violation of Public Law 518. To get to our figures, about half of the 4500 registered chemical uses have either tolerances or exemptions, or have been recognized as safe. These determiniations have been reached either under the pesticide residue hearings of 1950 or under the provisions of Public Law 518. In addition, there are many uses which have been registered without a tolerance or exemption because they have been proven to leave no residue. These figures show that real progress has been made toward bringing registered uses into compliance with the Federal Food, Drug, and Cosmetic Act. They also show that there are still an appreciable number of uses in an undetermined status. Such uses are questionable because either proof is lacking that, when used as directed, they result in no residue or because proof is lacking as to precisely what residue does result.

So we've made significant progress in bringing agricultural chemicals into line with the provisions of P. L. 518. The job is not entirely complete, primarily due to a lack of data which will prove just where some of these older uses stand under the provisions of the law. I say the older uses because it is virtually entirely in this area that proof of residues is lacking. With respect to the newer uses, it has been the policy of the USDA, since the passage of P. L. 518, not to register a new use until a tolerance or exemption has been established for it, or there was adequate proof of no residue.

In conclusion, let's discuss the effect of P. L. 518 on the operations of people at the state and county levels and upon the growers you serve. Certainly all of us are anxious to avoid seizures of crops or prosecution of folks who ship farm products interstate. The best rule which I can offer you today is to follow the label. Use the material only on the crops cited on the label. Use it only in the amounts specified and at the times stated on the label. We suggest reference to the label because as I mentioned earlier tolerances and exemptions have been established for about half of the registered uses on food or feed crops. In addition, other uses have been shown to leave no residue when used in accordance with label directions. Also, while reviewing labels for registration under the Federal Insecticide, Fungicide, and Rodenticide Act, even before passage of P. L. 518, it was the practice for USDA technicians to obtain concurrence of the Food and Drug Administration as to the absence of hazard to consumers, when a label proposed a possible residue problem. Therefore, while many older food and feed uses do not have tolerance or exemptions and thus may not be technically in compliance with P. L. 518, it appears unlikely that their continued use until clearances have been obtained will present a public health hazard because of resultant residues. Consequently, we believe that the registered label is the best single guide for you folks and your growers to follow.

Of course, situations will arise from time to time under local conditions, where the pattern of use on the label may not give the best results in pest control. We must remember that labeling registered with the USDA is on a national pattern. Label directions do not and could not practically allow for differences in soil and climatic conditions in the various geographical areas in the country. This means that there will at times be a tendency to deviate from the pattern of use as set forth on the label, and it is true that in some situations such deviation may be justified. However, we strongly urge you and your growers to seek the advice of your experiment station before taking such action. If their work under local conditions proves that a material may be used in greater amounts than the dosage prescribed on the label or closer to harvest than label directions



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specify, all well and good. However, without such a sound basis for exception, encourage your growers to follow the label. During this transition period, until we have a sound, scientific and legal basis for all agricultural chemical usage the registered label and your experiment station recommendations are the best guides to safe pesticide chemical usage.

[1] Assistant Head, Pesticide Regulation Section, Plant Pest Control Division, Agricultural Research Service, U. S. Department of Agriculture

## CANADIAN LEGISLATION AFFECTING HERBICIDE LABELLING AND USE

**C. H. Jefferson** [1]

The government of Canada, that is, the Federal Government, enacted legislation in 1927 which provided for the regulation of herbicides and other pesticides. This legislation was revised in 1939 when the current Pest Control Products Act was passed. This statute applies to all herbicides sold at the retail level in Canada and in this respect combines the type of jurisdiction embodied in the U. S. Federal Insecticide, Fungicide and Rodenticide Act with that of state legislatures.

In addition to this Federal statute, one of the provinces, the Province of Ontario, has enacted "The Pesticide Act" which provides authority to regulate the use of pesticides, including herbicides, within that province.

The statutes referred to appear to be the only ones in force in Canada which relate to labelling and use of herbicides. In addition to these statutes, there are a number of provincial laws and municipal ordinances which relate to the control of weeds and some of these may have an indirect bearing on herbicide use.

The Pest Control Products Act administered by the Federal Department of Agriculture provides for compulsory registration prior to sale. The Minister of Agriculture is empowered to refuse registration, and thereby sale, if the product is believed to be unsuited for the purpose for which it is sold or represented, or if it is generally detrimental or seriously injurious to vegetation (except weeds), domestic animals or public health used according to directions. This authority is actively used to assure, insofar as possible, that the herbicides available on the Canadian market are safe and useful when used as directed.

Registrations are granted for a maximum of one year, all certificates of registration expiring at the end of each calendar year. Registrations may be renewed annually. Applications for registration set forth the complete formula including the names and percent of inert ingredients as well as the active ones. This information is held in confidence and is available only to the registration and departmental reviewing officers. Applications also include full statements of the labelling, claims, cautions and directions for use. The assessment of the product's acceptability for registration can in most cases be completed on the basis of information available to departmental personnel from sources other than the registrant. In cases where information is lacking, it is the responsibility of the applicant to provide the necessary data to justify and confirm the usefulness and safety of the product. Nearly all new herbicides are rather extensively field tested by Federal Department of Agriculture weed workers and by other members of the National Weed Committee prior to the request for registration. The decision to apply for registration, and subsequent registration, is usually largely based on the results obtained in this testing program.

The granting of registration under the Pest Control Products Act does not denote Government approval per se. Registration, therefore, should not be construed to mean departmental approval or endorsement for the proprietary product concerned. As a matter of fact, statements implying or inferring that a herbicide is approved, accepted, or recommended by the Government of Canada or by any department or service thereof, may be an offense under the terms of the Act. While in many instances registrants choose to represent their products for use in a manner identical with the recommendations of weed workers and provincial extension agencies, somewhat lower performance standards may also be accepted for registration purposes. In administering the P.C.P. Act "suitability for the purposes claimed" is considered to include a performance level somewhat below the optimum obtainable. This leaves room for some differential in value between proprietary products, yet removes the likelihood of herbicides being available on the market which are absolutely useless or practically so. The minimum standard for registration purposes is gradually raised as new developments bring more efficient herbicides into the market. The standards used are not stated in definite terms as this would be difficult to do, and thus far there has not been a need for such precision.

Herbicides must bear labels which are descriptive as to name, purpose, active ingredients, net quantity and the registrant.

The name of the product or statements in close association with it must indicate the nature of the product, its general purpose and physical form.

The ingredients are stated in a guarantee which names the active ingredients and expresses their content quantitatively. For powders and dry formulations, this content is stated as a percent wt/wt. When the formulation is a liquid or a suspension, the content is expressed by weight (ounces or pounds) per Imperial gallon. The active ingredients are referred to by common name and in those terms which are used in stating rates of application.

An attempt is made to keep these guarantee statements on common ground so that the user may make comparisons between one proprietary product and another without having to know the molecular weights, specific gravities and other physical characteristics of the chemicals involved. For example, all 2,4-D products irrespective of formulation express their quantitative strength in terms of 2,4-D, the acid.

The enforcement of the law is carried out in part by a staff of inspectors strategically located across Canada. They are organized in eight districts and while they have responsibilities other than the enforcement of the Pest Control Products Act, they are able to keep a fairly close watch on all herbicide products offered for sale. Several hundred samples are taken each year for a check of the labelling as well as for chemical analysis. Few serious deficiencies are detected and judging by the lack of complaints from users, herbicides are generally very satisfactory.

There are in the neighbodhood of 400 different proprietary herbicide formulations registered for sale in Canada. These contain about 40 different active ingredients. Registrants total 81, of which 22 are foreign—mostly from the United States.

The invoice value of herbicides sold in Canada in 1957, the last year for which figures are available, totals nearly 6.5 million dollars which represents about one-third of the value of all registered pesticides sold in Canada.

With further reference to The Pesticides Act of the Province of Ontario, it can be stated that regulations at present do not refer to any herbicidal products. This Act provides that pesticides in general may be used in Ontario only under license or permit, excepting for use by persons on their premises. The authority is provided, however, to require permits even under such conditions of use in the case of highly dangerous materials. Custom spray operators are also exempt from the provisions of the Act when they perform weed control service for farmers. At the present time, therefore, this Act does not have much if any impact on the use of



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herbicides in Ontario but it does provide the authority for the regulation of use when the need arises.

These brief comments are intended to give a resume of the legislation which applies to the labelling and use of herbicides in Canada. Further details can be obtained by writing to the offices administering the two statutes noted. The Pest Control Products Act is administered by the Plant Products Division, Canada Department of Agriculture, Confederation Building, Ottawa, Canada. The Pesticides Act of Ontario is administered by the Ontario Department of Health, Queen's Park, Toronto, Canada.

[1] Supervisor, Pesticide Unit, Plant Products Division, Canada Department of Agriculture. Presented by K. W. Hill, Dominion Experimental Farm, Ottawa, Canada.

## MINNESOTA ECONOMIC POISONS AND DEVICES LAW AND RULES AND REGULATIONS RELATING TO THE ENFORCEMENT THEREOF

**Sig. Bjerken** [1]

I shall briefly explain the main provisions of the Minnesota Economic Poisons and Devices Law, Minn. Statutes, Laws 1945, Chapter 427, Section 24.02, Subd. 1, 6, 17; Sections 24.071, 24.072 as amended, 24.073, 24.074, 24.075, 24.076, 24.077.

**Economic poison** under the law shall include any substance or mixture of substances intended for use in preventing, destroying, repelling, or mitigating any and all insects, rodents, fungi (including bacteria), weeds, and other forms of plant or animal life which the Commissioner of Agriculture, Dairy and Food shall declare to be a pest.

**Label:** The label shall contain the following mandatory information: (1) the name, brand, or trademark of the product; (2) the name and address of the manufacturer or distributor; (3) the net weight or measure as the case may be, which is contained in the package; (4) a complete ingredient statement.

**Herbicide:** The term "herbicide" shall include any substance or mixture of substances intended for use to prevent, destroy, repel or mitigate weeds or other forms of plant life which the commissioner shall declare to be a pest.

**Labels:** Any economic poison determined by the commissioner to be highly toxic to man shall bear upon the label in plain, legible type, (1) the word "poison" on a background of distinctly contrasting color, and (2) an antidote, if known, for the poison or poisons contained therein and (3) the skull and crossbones.

**Registration:** Any person before selling or offering for sale any economic poison shall annually file with the commissioner of Agriculture a label of each product together with an application for registering the product.

**Fees:** The fee is $7.50 for each five products registered by any one firm and $2.00 for each additional product registered. Every registration shall expire on June 30 following its issue and no certificate of registration shall be issued for a term longer than one year, and shall not be transferable from one person to another or from one place to another place or location. There is a penalty of 50% of the license or registration fee if the license is not applied for on or before July 1 of each year, or within the same month such economic poisons are first manufactured or sold within this state.

**When law is not applicable**—The provisions of this law shall not apply when economic poisons are in transit through the state or in storage within the state intended for and sold outside of the state.

**Penalties:** Any person violating any of the provisions of the Economic Poisons Law or any regulations made thereunder, upon conviction thereof shall be punished by a fine of not less than $25, or by imprisonment in the county jail for not less than 30 days for the first offense and in the sum of not less than $50 or by imprisonment in county jail for not less than 60 days or both for each subsequent offense.

**Regulation No. 1**—Words used in the singular form shall include the plural and vice versa, as the case may require.

**Regulation No. 2**—Pertains to the terms defined and construed in the law.

**Regulation No. 3**—Labeling of products sold in the United States shall be in the English language. Articles intended for distribution to points outside of the United States the appropriate foreign language may be used.

**Regulation No. 4**—The common name of the ingredients must be given. If ingredient has no common name the correct chemical name. If there is no common name and chemical composition is unknown or complex, the Commissioner will permit the use of a new or coined name.

**Regulation No. 5**—Pertains to laboratory tests of products highly toxic to man with the use of rodents, etc.

**Regulation No. 6**—Pertains to the procedure for registration.

**Regulation No. 7**—Coloration and discoloration provisions are set forth in this regulation. The white economic poisons named shall be colored or discolored in accordance with this section.

**Regulation No. 8**—Pertains to methods of examination of samples adopted and published by the Association of Official Agricultural Chemists, where applicable, and such other methods as may be necessary to determine whether the product complies with the act.

[1] Minnesota Department of Agriculture, 308 Agricultural Botany Building, University of Minnesota, St. Paul.

## THE WISCONSIN ECONOMIC POISON LAW[1]

**H. E. Halliday**

The Wisconsin Economic Poison Law has been in effect for about six years and is of increasing importance to the state particularly since the passage of Public Law 518, commonly known as the Miller Bill.

The mechanics of registration and the field work are under the supervision of H. E. Halliday, who is in charge of the Economic Poisons Section. He is directly responsible to E. L. Chambers, chief of the Division of Plant Industry and state entomologist. Approximately 4000 brands are registered each year by 450 registrants.

The Wisconsin law falls between the federal law and the model law and its provisions are reasonably adequate for its purpose. Various types of materials which probably will be added to the federal law shortly such as the desiccants, defoliants, growth regulators, and other plant hormones were included in the original Wisconsin law. A few regulations may be asked for in the future to aid in the enforcement of some of the law's provisions.

There has always been close cooperation with the federal registration office on the many problems regarding use of the modern pesticides. Directions for use as they appear on the label are probably the most important statements on the label today. They concern safety, effectiveness, and reasonable assurance that there will be no residue in excess of established tolerances. Today these three factors are so closely tied together that they can scarcely be separated. Many products are effective but unsafe for most persons to use except with very adequate protection. Others are effective and safe, but will leave excess residues. There are also some instances in which effective control is made difficult because the choice of materials which can be used is small after safety or residue factors are considered.



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Fortunately, chemical weed control has not presented quite as many problems as have many other pesticide uses. Many chemicals used for weed control on crops either leave little residue or are relatively nontoxic. The safety of other nearby susceptible crops must be kept in mind when using most of them, and safety to livestock with a few.

While pesticide residues on any food crop are important, milk probably presents the outstanding problem. As you know, milk and dairy products are Wisconsin's major farm commodities. No residues of any kind are tolerated in milk because it is the principal food of babies, invalids, and is used extensively by children.

In order to keep milk free of all contaminants, Wisconsin has spent millions of dollars eradicating livestock diseases, building sanitary milk houses, and enforcing regulations regarding sanitation and cleanliness. Now, in addition to these, milk must be protected against contamination by pesticides. We must control insects, diseases, and weeds in our pastures and forage, milk utensils and dairy equipment must be kept sanitary, dairy cows have to be kept free of insects if they are to produce to capacity. All of these problems involve use of pesticides. In most cases acceptable usage of pesticides are established in the federal labeling office with the concurrence of the Federal Food and Drug Administration. This is of great service to the various states because it assures that most pesticides moving in interstate commerce will be correctly labeled. On a few occasions particular conditions in our state have made it necessary for Wisconsin to ask for different labeling than that which is acceptable in large portions of the United States. The Wisconsin Economic Poison Law makes it possible to help keep labeling uniform, but it is also helpful in requiring labeling in the few instances in which particular conditions make it necessary.

An economic poison registration law can provide correct labeling of pesticides but it cannot prevent misuse, and constant education of the public using pesticides must be continued.

[1] Prepared by H. E. Halliday and presented by Howard T. Richards, Wisconsin Department of Agriculture.

## HOW WEED CONTROL FITS INTO SOUTH DAKOTA A.C.P. PROGRAM

**Keith Wallace** [1]

South Dakota has had an A.C.P. weed control practice since 1944, except during 1954 and 1956. In order to understand how this practice fits into the South Dakota picture, we should consider some climatic and economic factors of the state. First in importance is rainfall, which is limited. Farming is done on an extensive basis with large acreages being used to offset smaller yields due to limited rainfall. Attempting to grow a crop in an area infested with a noxious weed under these conditions sometimes results in complete loss of the crop and always results in yield reductions of ⅓ or more.

Land values have been an important factor in determining the necessity of our South Dakota weed program as well as this A.C.P. weed practice. These values are of course determined by productivity, which is limited by rainfall, but the important consideration is that cost of elimination of established stands of noxious weeds is more than the established land value over much of the state. In areas of severe infestation this has resulted in conditions that would indicate necessity for action. Some of the more important are: (1) value of badly infested land has dropped as low as 5-10% of original value (2) reduction in land valuation for tax purposes by as much as 50% (3) badly infested farms being sold to unsuspecting customers during the winter while covered with snow. These conditions do not prevail widely over our state but it is what you might term "the hand-writing on the wall." Should noxious weeds be allowed to spread, productivity of our land will be destroyed no matter how perfect other soil conservation practices have been established. There is no single hazard that is more destructive to our land than perennial noxious weeds.

This would indicate the need for a program to eliminate limited infestations and protect our land from general infestation. I choose to call this an insurance program. This is important as it points out that our ASC practice is not designed to treat all the weeds in South Dakota. Its primary purpose is to *eliminate* (not control) some weeds that are a real threat to the future of agriculture in the state.

With this as a background let us look at the practice and how it has evolved since its inception in 1944. It has always been an F2 practice which is initiated in the county. (However, usually the practice is written at the state level and suggested to eligible counties.) This has been a disadvantage as it was not known if approval would would be given from year to year.

At first the practice was comprised largely of the soil sterilants for eliminating small patches of our eight perennial noxious weeds. Later as research found new weed control methods they were added. The addition of new findings such as the use of 2,4-D brought new administrative problems. Although we feel these have largely been solved they were real problems at the time. One of the main problems in the area was that some wanted to spray all the weeds on the farm. Correcting this was an educational effort, a matter of better informing the public as to the purpose of the practice.

In 1954 approval was not given to the F2 noxious weed practice, supposedly for the above stated reasons. However, it was learned later that more than administrative problems were involved.

In 1955 the practice was reinstated and contained operations that were component parts of a three year program. This was designed in conformance with research findings at South Dakota State College. This was a big step forward but the practice was approved from year to year while three years were required for its completion. This has since been corrected by legislative action which essentially prevents deletion of a practice before completion is possible by those participating.

In general the 1955 practice was a good one and gained general acceptance, but in 1956 approval was again refused. In 1957 the practice was reinstated because of general interest of the farmers. However, that year it was handcuffed by red tape from Washington, D. C. By this time it was obvious that one agency was opposing this weed practice, quietly but effectively.

By the summer of 1957 farmers in general became aware of the situation and started working through county weed boards, county ASC committees and personal efforts. One county weed board sent their supervisor to Washington, D. C. where the matter was discussed with congressmen and officials. In December the state weed board arranged a meeting of all county weed boards, county ASC committeemen and South Dakota's congressmen for the purpose of letting the congressmen know the farmers' feeling about a weed practice. By the time the meeting was held, state ASC officials, who had always been favorable to the practice, received word that approval would be given for the next year. Many have asked that the practice be included in the national A.C.P. docket to eliminate uncertainty from year to year, however, it is still being used as an F2 practice.

The 1958 and 59 practice has a great deal of flexibility; it is able to take care of a wide variety of situations. It is composed of two main parts: (A) for large infestations, primarily a three year program, (B) for small patches, using soil sterilants. Part A has seven possible operations which are combinations of chemi-



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cals and cultivations. These may be used in thirty-five different combinations, depending on the weed to be eradicated and the desire of the farmer. Approval for use of this practice is limited to counties with active weed control programs.

Space limitations prevent printing the entire South Dakota A.C.P. weed practice here.

Nothing worthwhile is ever accomplished without a certain amount of conflict. Our A.C.P. weed practice is working and serving a useful enduring purpose for South Dakota agriculture. An informed public, an active weed program, and the interest of the A.S.C. program officials made this possible.

[1] Department of Agronomy, South Dakota State College, Brookings.

## SOME EFFECTS OF CHLORDANE ON GERMINATION AND GROWTH OF TURF GRASSES

**G. H. Egley and B. J. Rogers** [1]

Chlordane, usually known as an insecticide, is being used with some success as a pre-emergence chemical for the control of crabgrass in turf. One would expect chlordane to be a general poison at the cellular level, since it is active in both the animal and plant kingdoms. However, this may not be true, as will be seen later.

As a starting point in our study we used materials with which we are reasonably familiar; i.e., turf grasses. Various species of grass were sown in flats and treated both pre- and post-emergence with different amounts of chlordane. The post-emergence applications were made when the grasses had reached a height of ½-1 inch. Usually the chlordane was applied in a 5% dust formulation at concentrations of 65 and 85 lb/A of actual chlordane. Most recommendations suggest 65 lb/A or less; our field tests indicate that 85 lb/A is a more suitable application. Other tests were run in petri dishes; seeds were placed on filter paper over a quantity of 5% dust. This procedure resulted essentially in the constant exposure of the seeds to a chlordane-saturated water solution. Germination and root and shoot growth could be followed more closely with this procedure.

The pre-emergence tests indicated variations in tolerance to chlordane. Tall fescue was particularly tolerant, whereas Merion bluegrass and Chewings fescue were rather sensitive. Results are given below.

| | Percent survival | |
|---|---|---|
| | 65 lb/A | 85 lb/A |
| Cr. red fescue | 72 | 36 |
| Chewings fescue | 27 | 17 |
| Tall fescue | 100 | 90 |
| Perennial rye | 85 | 50 |
| Italian rye | 52 | 29 |
| Highland bent | 38 | 33 |
| Redtop | 44 | 10 |
| Merion bluegrass | 30 | 20 |
| Kentucky bluegrass | 55 | 21 |
| Goosegrass | 33 | 33 |
| Crabgrass | 43 | 30 |

Post-emergence treatments indicated that chlordane is not particularly toxic to plants which are established fairly well; there was little if any reduction in stand for any of the species examined.

The petri dish experiments gave some clues as to the manner in which chlordane acts as an herbicide. There was a reduction in germination which varied with species, and those seeds which germinated produced abnormal seedlings. Particularly striking was the reduction in root growth; this reduction by itself possibly could account for the observed decrease in shoot growth. Work done in England recently has shown that chlordane interferes with cell division in plants, and also that a certain fraction of commercial chlordane preparations is lethal to resting cells; these phenomena easily could account for the observed reduction in growth. It was also shown that once the plants are removed from contact with chlordane they recover. When one compares this action of chlordane with that in insects, where it is thought to interfere with the central nervous system, then it appears that chlordane must be something more than a general cellular poison.

The results of this study have obvious practical applications. The increase in tolerance once these grasses have been developed a root system accounts for the safety with which chlordane may be used in established turf. At the same time, it would not be safe to apply chlordane to a newly-seeded lawn; particularly a bluegrass lawn. The large reduction in root growth could account for the variability in reports of field control of crabgrass. If crabgrass plants were well supplied with water and nutrients, they might overcome a chlordane treatment, if growing under conditions of moisture stress, with a poor root system, they probably would die.

[1] Purdue University, Lafayette, Indiana.

## PREVENTING CRABGRASS IN TURF AREAS

**W. H. Daniel** [1]

Research has shown that it is easiest to control young seedlings of weeds as they germinate. Therefore, much of the research on principles of weed control has been directed to young seedling weeds in all crops. And in turf, the toxicity of arsenic, chlordane, or other compounds is aimed at killing the crabgrass before it passes the seedling stage. Although seeds in the soil can or might be killed by chemicals, it is only when that seed sprouts that it is important, thus seedling kill is satisfactory. Research has also shown that to be satisfactory pre-emergence control must be almost perfect otherwise the few remaining plants may be as obnoxious as those in untreated areas.

**Arsenic toxicity.** The arsenic susceptible plants include hairy and smooth crabgrass, common and mouse-eared chickweed, yellow and green foxtails, plus witchgrass and barnyard grass. Both established and young *Poa annua* plants are reduced in vigor by arsenic toxicity. Of the turfgrasses, established bluegrass, bentgrasses and redtop are quite tolerant of arsenic, and even young seedlings survive applications that are toxic to crabgrass. Ryegrasses, Bermuda and Zoysia are not as susceptible as are weedy grasses. Many plants have not been observed.

**What industry offers.** For many years lead arsenate and calcium arsenate have been available as fine powders for uses as sprays and dusts in insect control. Currently about 50,000,000 pounds of each are produced annually. Although much about arsenic toxicity has been known and was reported more than 20 years ago by Grau, Welton, Monteith and others, comparatively little arsenic was utilized for selective weed control.

Research at Purdue University on *Poa annua* control with arsenics was started in 1952. *Poa annua* control was reported in 1952 and has been extensively observed on various test plots every year since then. Crabgrass prevention was recorded in 1954, and on 15 different sites replicated experimental tests have provided reproducible data showing effective crabgrass control.

In 1958 at Purdue, five forms of arsenic material, when used at recommended rates in six test sites, averaged over 90% control of crabgrass infestations. In more



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than half the tests (10 out of 17) four materials gave 98% crabgrass reduction.

**Table 1. Percent reduction in crabgrass infestation when used at recommended rates.**

| | Material Application lb/1,000 sq ft | Control pct |
|---|---|---|
| Calcium arsenate 70% | 12 | 93 |
| Calcium arsenate 85% | 10 | 87 |
| K-420 (Acme) | 12 | 99 |
| PAX (Kelly Western) | 25 | 84 |
| Lead arsenate | 24 | 79 |
| Chlordane (active) | 2 | 70 |

Recent work on control of weeds, accompanied by extensive production research and development by industry, has resulted in products more easily handled and specifically prepared for pre-emergence weedy grass control for lawnowners and turf supervisors. At present. tentative reports show at least eight merchandisers will have trade name products available for spring market. All of these formulations attempt to apply enough material to be toxic whenever crabgrass or susceptible plants might emerge. After initial use, annual rates of one-third to one-fourth as much should be adequate to keep toxicity at the soil surface.

**Chlordane toxicity.** For several years, variable crabgrass control has been observed on research plots in turf and other crops given heavy chlordane treatments. Sometimes perfect control is secured, but, percentages of from 100 down to 50% have been reported by several stations. Research results at Purdue, since 1951, have also been variable with 84, 80, 60% control reported.

Chlordane's effect on young seedlings is to stop the seedling growth immediately after emergence and before true leaves develop. Further careful research on selectivity between species is needed, but most seedlings are susceptible. Some may wish to try chlordane in rose beds or elsewhere for use after weeds have been removed and plants are well established. As of January 1, 1959 there are at least two trade name products, plus the standard forms of chlordane products, on the market.

**Other compounds.** Several chemicals, including 2,4-D, 2,4,5-T, Sevin, erbon, sesone, neburon, NPA and other related compounds and products, may prevent establishment, or kill new (less than 3 leaved) seedlings. Usually an early spring application (by the time dandelions bloom) may kill broadleaf seedling weeds, young knotweed and reduce early crabgrass infestation. Rates of 1 to 2 lb/A (standard rates) may be effective for 3 to 4 weeks. Some preparations combine weed killers with fertilizers or vermiculite for spreader applications as dry forms. These materials must be used with caution around shrubs, gardens and flowers. Furthermore, there is no protection against delayed or later crabgrass infestations unless repeat applications are made every 3 or 4 weeks until mid-summer.

Pre-emergence control of crabgrass does offer a chance to enjoy good grasses with much less weedy grass infestation and competition. However, for satisfactory results the principle of toxicity should be understood and the materials carefully applied.

[1] Turf Specialist, Purdue University, Lafayette, Indiana

## POA ANNUA CONTROL IN TURF

**N. R. Goetze** [1]

*Poa annua* develops one of the best quality turf covers known in the cool season turf belt. Unfortunately it is an annual and completes its life cycle in hot dry periods of midsummer. During cool or moist seasons the period between death of the previous crop and germination of the new one is often shortened. In the more southern locations, length of period between successive crops of *Poa annua* becomes longer and the problem increases in severity. The enthusiasm for classifying *Poa annua* as a serious turf weed therefore varies with the individual season and the geographical location.

This study has been based on the premise that because of its inconsistencies *Poa annua* should be controlled or restricted to encourage the more desirable turf species. Also the restriction of the *Poa annua* should come at a time in the season when the desirable turf grasses are best able to fill the vacancies formerly occupied by the *Poa annua*.

Extensive field and greenhouse testing has demonstrated that selective removal of this weedy grass from other turf grasses is possible. A screening trial including 23 experimental herbicides applied at five different times during the growing season of 1955-56 demonstrated that *Poa annua* could be selectively controlled in turf.

Four organic herbicides from the original group of 23 showed satisfactory selectivity between *Poa annua* and *Poa pratensis*. They were CDAA at 6 lb/A, a mixture of trichlorobenzoic acids composed primarily of 2,3,6-TBA at 2 lb/A, *P,P*-dibutyl-*N,N*-diisopropylphosphinic amide at 4 lb/A, and neburon at 4 lb/A. Both calcium and lead arsenate also were active in these tests.

Later experiences with CDAA and related compounds were disappointing because of damage to desirable turf. Pelleting of the materials to avoid contact injury by the carrier resulted in a product which was generally not effective on *Poa annua*. *P,P*-dibutyl-*N,N*-diisopropylphosphinic amide was discarded from the trials because of rather inconsistent results. 2,3,6-TBA under closer observation generally was not completely effective and also caused some damage. Neburon at 4 lb/A has satisfactorily controlled *Poa annua* in bluegrass lawns but damages both fineleafed fescues and bentgrasses. It is most effective when applied preemergence but also seems to be active on young plants as a post-emergence spray. In a few isolated instances it has selectively killed *Poa annua* when applied while *Poa annua* was in bloom. Under turf conditions, its residual activity is short and two applications per year are suggested.

For control of *Poa annua* in turf containing fine leaf fescues or bentgrasses the inorganic arsenical materials have shown the greatest degree of success. Earlier work has shown that toxic quantities of arsenic can be built up on the soil surface layers. Germinating seedlings of *Poa annua* then pick up small amounts of arsenic and are killed at a young age. This method involves rather large amounts of material (120-200 pounds of metallic arsenic per acre). Since *Poa annua* germinates over a long period, the results are not too striking immediately.

Recent trials have tested various formulations of inorganic arsenicals applied just prior to the early fall germination period. (August 15-18). Preliminary results on October 31 indicated that the materials having higher percentages of water soluble arsenic had reduced the new stands of *Poa annua* by 50% with no damage to the bentgrass putting green surface. Materials having smaller amounts of water soluble arsenic were not as immediately effective, but the *Poa annua* was beginning to develop characteristic yellowing typical of early symptoms of arsenic toxicity. Damage to the bentgrass was neglible in the Northern Illinois locations but the damage increased in the St. Louis area. In all but one location the severity of damage to the bentgrass was directly related to the water soluble arsenic content. On a green having 1½ inches of mat materials having medium amounts of water soluble arsenic caused the most bentgrass damage. It was hypothesized that since most of the active bentgrass roots were located in the heavy mat, arsenic materials which remained in the mat zone for the longest period were the most dam-



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aging. Compounds having high water solubility could have moved quickly through the mat without damage while those moving more slowly could have remained in the root zone sufficiently long to cause damage to the bentgrass.

This work has indicated that *Poa annua* can be controlled in most northern turfgrass situations. The control measures are usually not 100% effective and repeated treatments may be needed. The use of herbicides is not a panacea for *Poa annua* control but instead is one of more important factors of good management.

[1] Department of Agronomy, Purdue University, Lafayette, Indiana.

## POST-EMERGENCE CRABGRASS CONTROL STUDIES

**J. B. Beard and W. H. Daniel** [1]

Extensive post-emergence crabgrass control studies have been conducted at Purdue University over the last four years. These tests have encompassed 34 compounds in 13 individual studies. Tests in 1954, 1955 and 1956 indicated the disodium salt of MAA (DMA) to be the most effective and safest crabgrass control chemical currently available at that time for widespread home owner use.

In 1957 studies were initiated to evaluate other materials which might give faster control and might require only one application. These tests proved 8 related organic arsenicals to be superior in activity to DMA. Of these 8 the mono-octyl ammonium salt of MAA (AMA) was found to be the best. It gave a faster and a more positive control, but it still required two applications.

A later study was conducted to determine what effect varying the pH of the DMA formulation would have on its crabgrass control properties. Varying the pH was shown to be if little benefit and a pH of 4 or lower decreased the toxic action of the DMA considerably. Also, it was found that mixing wetting agents into the DMA formulation was of little benefit.

Tests were carried out to determine the proper number of applications and intervals between application of AMA and DMA required at both the 5 and 10 lb/A rates to give the maximum crabgrass control. The number of applications ranged from 1 to 4 with intervals between applications of 1, 2, 4, and 8 days. The best and fastest crabgrass control with both materials and both rates was obtained with 2 applications at a 5 to 7 day interval.

In the summer of 1958 further investigations were made concerning various formulations of AMA and DMA. It was found that mixtures of 75% t-nonyl AMA plus 25% dodecyl AMA at 10 lb/A and 50% t-nonyl AMA plus 50% dodecyl AMA at 10 lb/A gave equal but not better control than standard AMA alone. It was also shown that AMA in a dry form at 10 lb/A gave much faster control than DMA in a dry form at 10 lb/A. Both required two applications but the dry AMA form gave a much quicker discoloration and browning of crabgrass with no damage to the desirable bluegrass.

Four new experimental materials were also tested in the summer of 1958. Two of them did not give as good a control as standard AMA or DMA. The other two materials have shown some promising characteristics.

This past summer's findings indicate that the dry AMA formulation warrants further study due to its more rapid killing properties. Also, the two new materials should be investigated more thoroughly because of their fast action. As yet we have not found a material which can be consistently used as a one-application eradicant of crabgrass.

[1] Department of Agronomy, Purdue University, Lafayette, Indiana.

## CONTROL OF NIMBLEWILL IN BLUEGRASS TURF [1]

**J. W. Herron** [2]

Nimblewill is a shallow rooted perennial grass that is becoming an increasingly important problem in bluegrass lawns in Kentucky. Its methods of reproduction are by seeds and creeping stolons. The tops die in late fall and winter, thus leaving unsightly brown areas in the lawn. In Kentucky vegetative growth from the nodes usually starts in February or early March.

Cultural methods for controlling this weed require constant vigilance and much work. Nimblewill can often be prevented from spreading by pulling scattered plants as soon as they are noticed. It is important to remove as many of the stolons as possible since even a small portion may develop into a new plant. Satisfactory control by this method is almost impossible on large infested areas.

In the summer of 1953 a study was initiated to determine if there was a selective herbicide that could be used for controlling nimblewill in lawns of Kentucky bluegrass *(Poa pratensis)*. Several herbicides were applied to mixed bluegrass and nimblewill turf at the following rates: potassium cyanate (KOCN), 25, 50, and 100 lb/A; sodium salt of TCA, 25, 50, and 100 lb/A; amine salt of DNBP, 4, 6, and 8 lb/A; MH, 3, 5, and 7 lb/A. Applications on different plots were made on May 31, June 30, July 28, and August 31. Similar treatments were applied in 1954.

Although top injury of both grasses occurred from treatments with KOCN and DNBP, they recovered by late summer or the following spring. Treatments with TCA resulted in more than 50 per cent kill of bluegrass as well as nimblewill. Top injury to the bluegrass resulted from treatments with MH the first season, but by the following spring there was over 90 per cent control of nimblewill on plots treated at the 5 and 7 pound rates, with no apparent reduction of bluegrass.

From results obtained in 1953 and 1954, it was felt that MH was the only herbicide included in previous experiments that warranted further testing in 1955. Applications were made in 1955, 1956 and 1957 at the same rates as in 1953 and 1954. Ten days after applications were made, one-half of each plot was shallow disked. Disking did not appear to increase the effectiveness of MH on either nimblewill or bluegrass.

These experiments showed that MH, applied at 7 lb/A, was the most effective chemical treatment for controlling nimblewill, with very little, if any, permanent injury to Kentucky bluegrass. Applications should be made when the nimblewill is making its most rapid growth. During extremely dry periods satisfactory control was not obtained. Spot treatments on smaller areas may be necessary in subsequent years.

The rates of MH used seem to be exceptionally high, and one would anticipate severe injury or complete kill of the bluegrass, but this is not the case. At the present time this treatment is not feasible for use on extremely large areas, but until a more effective and less expensive method of controlling nimblewill is found, MH may be a practical method for controlling this weed in the average home lawn.

[1] Published with the approval of the Director of the Kentucky Agricultural Experiment Station.

[2] Department of Horticulture, University of Kentucky, Lexington, Ky.

## CONTROL OF CHICKWEED IN TURF [1]

**B. H. Grigsby** [2]

The control of chickweed in turf has been a difficult task since the beginning of chemical sprays for broadleaved weed control. Early use of sodium arsenite and



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lead arsenate for crabgrass control also achieved some degree of chickweed control and the method is still used, especially by some golf course and cemetery superintendents. Home owners, however, are reluctant to use these materials. The advent of the general use of 2,4-D has placed more emphasis on the need for a safe and effective chickweed killer or preventive. In fact some requests for information suggest that the use of 2,4-D for weed control actually causes a chickweed infestation. The removal of other weeds tends to ease the competition between weed species and under these conditions chickweed does make more rapid and vigorous growth than it does in a mixed stand of weeds and grass.

Common chickweed is found mostly in home lawns and parks where the usual mowing height favors development of common chickweed. Mouse-ear chickweed is found in areas where a lower cutting height tends to destroy annual broadleaved weeds but permits perennial species capable of forming mats to develop at a rapid rate. For this reason, many putting greens become severely infested with mouse-ear chickweed.

The turf weed spray project at Michigan State University has included plots designed to assay herbicides as chickweed killers or preventors in each season since 1949. The materials which have given reasonably acceptable results are Stoddard Solvent, at 1 to 3 qt per 1000 sq ft; and the following at the indicated rates in lb/A; EXD, 5; DNBP, 3; neburon, 4; MCP, 2; DMA, 3; sodium arsenite, 4; 2,4,5-T, 2; silvex, 2; silvex + endothal, 1 + 2.

Turf for these tests has included pure stands of Kentucky bluegrass, bentgrass, and Merion bluegrass as well as mixtures of Kentucky bluegrass, Chewings fescue, ryegrass and bentgrasses. Evaluations of herbicides were based upon control of chickweed and color and density of the turf after treatment.

The chemicals listed above fall into two groups, (1) those which are effective on common chickweed and (2) those effective on mouse-ear chickweed, most of which also will control common chickweed.

**Common chickweed control.** Stoddard Solvent is suggested for use in areas where severe infestation has produced a need for re-seeding turf. The oil gives a quick kill, 4-12 hours, does not leave a toxic residue, does not kill roots of perennial grasses and permits immediate reseeding.

DNBP and EXD produce rapid kills but tend to discolor turf grass and require 2 to 3 weeks for decomposition of the chemical and thus delay seeding. Results with neburon have been erratic but satisfactory kill has been obtained. Best use of this compound is a fall application just before new seedlings emerge. In Michigan this is late September or early October. Turf less than 1 year old may be severely injured by neburon.

DMA, applied as a control for crabgrass, has been highly effective on common chickweed and may be used at any time during the growing season. Best results are obtained, however, when temperatures are above 70 degrees and full sun follows the application.

Common chickweed is a good indicator plant for the specificity of substitution in the phenoxyacetic acid compounds. 2,4-D has little effect upon this species but MCPA is highly effective on actively growing chickweed. We have obtained excellent kills in late fall and early spring, both seasons coinciding with rapid vegetative development of the weed.

**Mouse-ear chickweed.** This species is a perennial plant and generally has not responded to the action of contact herbicides and is also resistant to many of the translocated materials.

2,4,5-T has given erratic results and the rates required for positive control have caused definite injury to turf grasses, especially close cut bent.

Neburon, while it tends to prevent spreading by new seedlings, is not effective on established plants at rates which can be tolerated by turf grasses. 2,4-D, MCPA and mixtures of these compounds have been ineffective.

Satisfactory control of *Cerastium* can be obtained in most turf situations by an application of silvex made during the cool part of the growing season. A rate of 2 lb/A has been sufficient in our tests and has not caused permanent injury to any grass species. Temporary red discoloration may develop in bent but this can be overcome by fertilization and watering.

A combination of 2 lb/A endothal and 1 lb/A silvex will give temporary suppression without any discoloration but the chickweed bases will survive and retreatment will be necessary. This combination has been used on golf putting greens during the season of play without causing comment by players. The substitution of DMA for endothal in the above mixture is not as satisfactory but should be considered if crabgrass is present.

Our current suggestions for the control of chickweeds are as follows:

1. Apply 2,4-D at 2 lb/A to remove susceptible weeds.
2. For common chickweed only use (a) in the spring; MCP at 2 lb/ or DMA at rate suggested for crabgrass control: (b) in the fall; MCP as in the spring, or if reseeding is to be done use Stoddard Solvent at 40 gal/A.
3. For mouse-ear chickweed or a mixture of mouse-ear and common use silvex at a rate of 2 lb/A in spring or fall. Avoid use of silvex in hot dry weather.

[1] Published with the permission of the Director of the Michigan Agricultural Experiment Station.

[2] Department of Botany and Plant Pathology, Michigan State University, East Lansing.

## LAWN WEED GRUMBLES

**Robert W. Schery** [1]

In 1955, in cooperation with Joseph W. Lentz, Scott Executive, the Lawn Institute undertook an evaluation of customer interest in lawn weeds. The customer continues to grumble today, but not always about the same things.

Are weeds of major importance to the home owner? Certainly. In response to a national press offer of lawn information 15,614 inquiries were received by the Lawn Institute on weed control, more than the combined total for fertilizers, soils, and equipment. 63% of the responses originated north and east of the Mississippi and Ohio Rivers, 25% from the border states and northwestern states, and 12% from the deep South. Weeds led inquiries in May, June, July, September; were second in April, August and October, in the 1955 season.

What are weeds to the home owner? Apparently many are diligently planting "weeds," especially coarse fescues and bentgrasses which home owners complain form disruptive clumps or patches in good bluegrass turf. April 1958 Popular Gardening reports results of a spring lawn clinic in Indiana, at which those attending were invited to bring weeds for identification. Two out of every three submitted proved to be tall fescue.

In 1955 nimblewill rated one inquiry to every 5 for crabgrass; in 1958 Mr. Lentz reports there were 2 nimblewill inquiries to every one for crabgrass. There were 2½ coarse fescue inquiries to each one for crabgrass.

There are probably several causes for these shifts, chief of which may be that new widely marketed herbicides make crabgrass less a problem. At the same time greater lawn sophistication has probably brought objection to coarse or off-texture grasses. Worst of all, lawn seed mixers have widely diluted good bluegrass blends with coarse fescue.

With consumer complaint trending away from crabgrass (since advent of the arsonates), a good selective



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herbicide for perennial pests such as nimblewill, tall fescue, and quackgrass should find quite a reception. For nimblewill there is report of one such product, and in our tests at the Lawn Institute we have been moderately successful in repressing it with two treatments of arsonate combined with 2,4-D or 2,4,5-TP. Blue grass is quite rugged and resists rates toxic to *Muhlenbergia schreberi*. This is hardly for home owners (since rates are critical and there may be some lawn discoloration), or for fine fescue and bentgrass, but it does suggest an approach. Nimblewill apparently has become more prevalent, at least in locations formerly dry but now receiving ample rainfall. Mr. Lentz notes that increased inquiry this year came mainly from Ohio west.

Bermuda in the bluegrass zone is another 1958 heavy cause for complaint, with no good (selective) answer. Inquiry was almost as frequent as for crabgrass, whereas in 1955 it was only about one-seventh as frequent. Perhaps an increasing consciousness about lawns in the South partly accounts for this, but it also may be due to Bermuda moving northward. Nutgrass is a similar situation.

Davis has dealt in print with bentgrass as a weed in Kentucky bluegrass lawns. With recent wet summers it is not surprising that bentgrass complaints were almost as voluminous as for coarse fescue, double those for crabgrass. Bent has always been a summertime prima donna, but the complaints seem to be shifting to its presence, not its failure.

Both in 1955 and 1958 chickweed was chief broadleaf weed. We think we have good chickweed herbicides, but the public is either not aware, or the materials have not been widely marketed, or have failed. In both surveys knotweed was the second most troublesome broadleaf, along with spurge, one for which there still seems to be no very good late season answer.

More complaints center on the speedwells. With *Veronica* resistant to 2,4-D it stands out while the susceptible dandelions and plantains succumb easily. As in 1955 there is still little inquiry or complaint about dandelion and plantain.

The general public seems little concerned about the named varieties. Excitement about Zoysia, noted in 1955, has passed. Merion is occasionally still "discovered," but little is yet heard about Park, Delta, or of red fescue varieties. There is now more inquiry about rust and mildew, not much of a problem before Merion was included in bluegrass mixtures.

[1] Director, Better Lawn and Turf Institute, Marysville, Ohio.

## RESPONSE OF CERTAIN UNICELLULAR GREEN ALGAE TO SEVERAL HERBICIDES [1]

**B. H. Grigsby** [2]

During the winter and spring of 1958, using, with some modifications, the method reported by Jansen et al, a number of herbicides were screened for possible algacidal value. For these tests a culture of the unicellular alga, *Chlamydomonas*, was grown in a medium consisting of 2 parts tap water and 1 part of a liquid soil extract. Early tests had shown that this medium was entirely suitable for this species and was superior to synthetic media such as diluted Shive's nutrient solution. Stock culture of the alga was obtained by inoculating flasks of soil extract with a single drop from an established culture. The flasks were held in a greenhouse held at a 60-70 degree range of temperatures. Continuous supplemental light was supplied by a single 40 watt fluorescent tube held 3 feet above the top of the flasks.

Tests were made by placing a single drop of the algae culture in a 4 oz paper cup filled with saturated perlite, and immediately adding two drops of the herbicide made up in either 5 or 10 ppm concentrations. The cups were held for 3 or 5 days and then the algae growth was rated on a 1-10 scale. The perlite was kept saturated during this period by frequent additions of tap water at the periphery of the perlite so that a minimum amount of disturbance of algae cells was produced. Untreated checks and copper sulfate treated (5%) cultures were maintained for comparison standards.

The chemicals used and ratings given are shown in Table 1.

**Table 1. Herbicides, concentrations and ratings on growth of Chlamydomonas.**

Rating scale: 1 = no visible effect; 10 = no visible growth.

| Herbicide | Concentration ppm | Rating 3 days | Rating 5 days |
|---|---|---|---|
| G 30027[a] | 5 | — | 2 |
| G 30028[a] | 10 | — | 2 |
| G 30031[a] | 5 | 3 | 9 |
| G 30044[a] | 10 | — | 4 |
| G 30451[a] | 10 | — | 9 |
| G 31435[a] | 10 | — | 2 |
| G 27901[a] | 10 | — | 8 |
| Simazin | 5 | 5 | 9 |
| Endothal | 10 | — | 9 |
| Dichlone | 10 | — | 2 |
| EPTC | 10 | — | 2 |
| CEEC | 5 | 2 | 2 |
| CDAA | 5 | 2 | 2 |
| DNBP | 5 | 2 | 9 |
| Bioquin | 5 | 4 | 5 |
| Copper sulfate | (5% sol.) | 10 | 10 |
| Untreated | — | 1 | 1 |

[a] These are triazine derivatives produced by the Geigy Co. See Index.

These results indicate that simazin at 5ppm, was an excellent algacide and that three other triazine derivatives also had algacidal value while four related compounds were not effective. Endothal and DNBP also were effective when evaluated at the end of the 5 day test. EPTC, CDEC, CDAA, and dichlone were not effective under the conditions of this test.

Other tests, using 15 gallon tanks and mixtures of filamentous and unicellular green algae have shown that simazin at 5 ppm was lethal to the algae and that the toxicity would persist in the tanks for periods up to 6 months. EPTC and CDEC, applied to the tanks as granular formulations were toxic to the algae but the effects persisted for not more than 4-6 weeks. Granular 2,4-D was not effective as an algacide, and appeared to have stimulating action on the unicellular forms. Copper sulfate and sodium arsenite, in the tank tests, produced good initial kills but regrowth was found in 3-4 weeks after treatment.

The lasting effects of 5 ppm of simazin suggest a practical use of this herbicide in greenhouse experiments with sand or nutrient solution cultures. Most higher forms of plant life will tolerate this concentration and the prevention of algae contamination should be of real value. We are now using simazin in tank tests of herbicides on submerged aquatics such as Potamogeton and Myriophyllum. Determining the effects of herbicides on these plants is greatly facilitated by eliminationof algal mats which otherwise would be formed.

[1] Published with the permission of the Director of the Michigan Agricultural Experiment Station.

[2] Department of Botany and Plant Pathology, Michigan State University, East Lansing.



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## CONTROLLING CATTAIL AND PHRAGMITES WITH AMITROL

H. H. Dill[1] [2]

At Mud Lake Refuge two species of cattail *(Typha latifolia* and *T. angustifolia)* are commonly found. Phragmites *(P. communis)* is also common. All grow in profusion over certain parts of the refuge, and there is need for control along the edges of most pools where several thousand acres require periodic thinning. Phragmites should also be eradicated along roadways and drainage ditches.

Carlsen (1956 at Mud Lake) succeeded in controlling cattail with amitrol. Treatment at 16 lb/A was effective, but at 2 lb/A was not. Intermediate rates were not tried. The replications on cattails were repeated in 1957 by the writer. In addition, replicated plots of phragmites were treated with amitrol using ground spraying equipment, and additional cattail plots were aerially sprayed.

**Methods.** Two ¼-mile transects were established for aerial applications of amitrol on both species of cattail. The plants were mature and growing in from zero to eighteen inches of water. On August 13, 1957, amitrol was applied as an aerial spray in a water solution with small amounts of non-toxic detergent and stricker-spreader. One transect was treated at the rate of 4 lb/A (2 swaths applying 2 pounds each) and the other at 6 lb/A (3 swaths). Each swath was 44 feet wide. (A cross-wind came up during the operation, which may have somewhat reduced the rates per acre.)

Amitrol also was applied July 31, 1957, at 8 lb/A as a ground spray to three ⅛ acre roadside plots of phragmites approaching full bloom, in from zero to four inches of water. A similar plot was sprayed September 6, with 4 lb/A to test the chemical on mature plants. The application was 20 gallons per acre and included small amounts of non-ionic detergent and sticker-spreader.

Stem counts were made of both cattail and phragmites in 1957 and in 1958.

**Results.** Counts of cattail along the transect aerially treated at 6 lb/A gave aproximately 21 stems per sq yd at treatment, and an average of 1.5 live stems per sq yd on August 21, 1958, or approximately 93% control. The transect treated aerially at 4 lb/A averaged 17.4 stems/sq yd, and 7 live stems/sq yd August 21, or control of about 60 percent.

Phragmites, when checked August 21, was eradicated by 8 lb/A and reduced from 5 stems per square foot to less than one per square foot by 4 lb/A—approximately 85% control. Cattail mixed with the phragmites in this plot showed 90 percent control.

**Discussion.** It has been the experience of most workers that cattails growing in water were more difficult to kill than those in semi-dry locations. Cattail treated at Mud Lake Refuge were growing both in water and on semi-dry land, and uniform rates of kill were obtained on both transects in water levels up to 18 inches in depth. Cattail in water in the phragmites plot treated at 4 lb/A was killed at a higher rate than that aerially treated at that rate. Drift from the aerially treated area probably accounts for the difference.

These results demonstrate that aerial spraying of cattail with amitrol may be used for practical game management purposes. Eradication of cattail and phragmites is sometimes desirable in managing wildlife but, more often, partial control whereby some interspersion with water is achieved will serve the purpose more satisfactorily. Therefore, the partial control at the lower rates of application is significant.

**Summary.** 1. Dense monotype stands of cattail and phragmites were controlled for practical game management purposes, with amitrol applied as ground and aerial foliage sprays.

2. Aerial application of amitrol to cattail at 6 pounds of active ingredient per acre resulted in 93 percent control; at 4 pounds per acre, 60 percent control was obtained. (Wind drift might have lessened the effectiveness of the aerial treatments.)

3. Amitrol was uniformly effective on cattail in water up to 18 inches deep, on phragmites in water up to 4 inches deep, and on drained soil. Ground application of amitrol at 8 lb/A and at 4 lb/A gave 85 percent control.

[1] Manager of the Mud Lake National Wildlife Refuge, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, U.S.D.I., Holt, Minnesota.

[2] The author wishes to acknowledge the assistance of Dr. L. W. Melander, Amchem Products, Inc., Ambler, Pa., which Company supplied the experimental chemicals.

## APPLICATION OF GRANULAR HERBICIDES FOR THE CONTROL OF SUBMERGED WEEDS

B. H. Grigsby [1] and James Smith [2]

During the past 4 seasons extensive tests of herbicides for the control of submerged aquatic weeds, chiefly *Myriophyllum* and *Potamogeton*, have been conducted in the Kent Lake area of Kensington Metropolitan Park. Test plots were laid out in a 20-acre lagoon where the water is relatively still and weed growth was dense in water of a 3 to 8 foot depth. Plot sizes ranged from 2500 square feet to 1 acre. Granular herbicides were applied to either ice or open water, depending upon the time of the year when treatment was made. Herbicides used are shown in Table 1.

Ice applications were made by means of commercial fertilizer spreaders, hand-drawn type for small areas and tractor-drawn for larger plots. The applications were made in March or early April while ice was still 6 to 8 inches thick or 2 to 4 weeks before spring break-up of lake ice. The results obtained indicate that the granules either penetrated the ice or were dropped into water as the ice melted. Plot margins, as shown by weed control, were as well marked as though mechanically formed on the lake bottom.

Most of the 2,4D preparations used were of unformulated esters without any emulsifying or solubilizing additives, thus appreciable concentrations of 2,4-D could not develop in the water. This prevented spreading of effects of 2,4-D into adjacent plots. However, the 1958 treatments included some commercial esters which contained emulsifying agents and some spreading effects were noted.

**Table 1. Herbicides, carrier, percent active ingredient and rate per acre used for control of aquatic weeds.**

| Chemical | Inert base | Percent active | Lb/A (active) |
|---|---|---|---|
| 2,4-D ester | Bentonite | 10 | 20 |
| | Bentonite | 10 | 40 |
| | Bentonite | 10 | 70 |
| | Attaclay | 10 | 40 |
| | Attaclay | 13.3 | 40 |
| 2,4-D acid | Attaclay | 13.3 | 40 |
| TCB | Attaclay | 25 | 40 |
| ATA | Attaclay | 25 | 40 |
| Silvex | Attaclay | 25 | 40 |
| 2,4-D ethanol | None | 25 | 40 |
| Dichlone | None | 100 | 20 |
| Sodium arsenite | Attaclay | 10 | 40 |
| CIPC | Attaclay | 10 | 20 |
| Urox | None | 5 | 5 |

Open water applications were made from a raft powered by an outboard motor. The herbicides were spread by whirl-plate type seeders. A hand cranked unit was used for small plots and a battery powered



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unit for the larger plots. Uniform scattering of 100 pounds of granules per acre was easily accomplished with this equipment.

The results obtained in this series of tests can be summarized as follows:

1. Immediate killing of top growth of water weeds is not generally accomplished by use of granular herbicides.
2. Deposition of granular herbicides on lake bottom is effective for the control of rooted species, submerged or emergent.
3. The mode of action appears to be the destruction of the root system.
4. New infestation by vegetative propagation bodies and seedlings is prevented when 2,4-D is present in the the the bottom mud.
5. Rates of 2,4-D in the range of 40-70 pounds per acre will control milfoil, coontail and potamogeton for periods of 2 to 4 years.
6. Time of application is important and generally should be early in the growing season. Summer applications are slow in bringing about a response but ultimately will destroy rooted weeds.
7. Rates of application used in these tests are sufficient to cause considerable effects upon the various aquatic forms which are normal components of the lake bottom. The higher rates have practically eliminated many species.
8. Only compounds of the general group of phenoxyacetic acid compounds were effective in controlling the weeds present in the test areas.
9. Seasonal variations in waterweed growth were found in both treated and untreated areas.
10. The depth of water appears to have no effect upon the amount of herbicide required to give control of submerged rooted aquatic weeds.

[1] Professor of Botany, Michigan State University.

[2] Forester, Kensington Metropolitan Park, Huron-Clinton Metropolitan Authority.

## THE EFFECT OF APPLICATIONS OF PELLETED 2,4-D UPON THE BOTTOM FAUNA OF KENT LAKE, OAKLAND COUNTY, MICHIGAN

**Frank N. Hooper** [1]

Grigsby, Hamilton and Smith (1956)[2] succeeded in controlling water milfoil *(Myriophyllum exalbescens)* in Kent Lake, Oakland County, Michigan, by applying pelleted 2,4-D to the lake ice in late winter. Since their report appeared, a number of companies have started to manufacture and market 2,4-D pellets for the control of aquatic weeds. Since this chemical is applied as a solid which presumably sinks to the lake bottom, large concentrations might be expected to develop in the mud-water interphase and might be hazardous to the bottom invertebrates inhabiting this stratum. Some preliminary and qualitative benthos collections from plots used by Grigsby, Hamilton and Smith in their successful experiment in 1955 indicated that little bottom fauna was present in the treated area. Clearly, some evaluation of the effect of chemical preparations of this type upon fish-food resources should be made before they are widely used in fishing waters.

Rectangular ½-acre plots were marked with metal stakes. These plots were located in a small bay near the upper end of Kent Lake. Bottom sampling stations were selected and marked within each of two experimental plots and at a control site. On December 23, shortly after the ice formed on Kent Lake, four samples were collected with an Ekman dredge at each of the three stations. On February 3-5, Mr. James Smith of the Huron-Clinton Metropolitan Authority treated the plots with 2,4-D pellets. The plot at Station 1 received 20 lb/A 2,4-D acid adsorbed on pelles of Attaclay. The plot at Station 2 received 40 lb/A of an ester of 2,4-D adsorbed on Attaclay. Mr. Smith believes that the pellets melted the ice and fell to the lake bottom soon after application. On April 25, shortly after the ice disappeared, a second series of bottom samples were collected at the three stations, sieved, and preserved in 10% formalin. Benthos was separated from debris in the laboratory by floatation and hand picking.

Most of the types of invertebrates that were present before treatment appeared in samples collected after treatment. Although there were no Odonata and caddis flies at Station 2 after treatment, the same was true of the control plot. These insects may have emerged before the spring samples were collected. The wet weight of bottom animals was considerably lower after treatment than before at all three stations, but the decrease was greater at the control station than at the stations treated with 2,4-D (Table 1). The total number of animals increased at Station 2 and the number of mayflies increased after treatment at all three stations. From examination of the samples, the decrease in weight was largely due to the disappearance of large, mature larvae of several species of midges. On the the other hand, the increase in number at Station 2 reflected the addition of large numbers of small midge larvae.

**Table 1. Wet weight and number of bottom invertebrates at 3 stations before (December 19, 1957) and after (April 23, 1958) 2,4-D treatments.**

| Station and treatment | | Weight grams per ¼ sq ft | Number per ¼ sq ft | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Total | Midges | Mayflies | Odonata | Caddis flies | Tubificida | Other |
| Control (no treatment) | Before | 0.72 | 505 | 438 | 34 | 9.5 | 2.5 | ..... | 21 |
| | After | 0.082 | 106 | 92 | 9.5 | ..... | ..... | 4.7 | ..... |
| 1. 20 lb/A 2,4-D acid | Before | 0.39 | 364 | 306 | 12 | 5.2 | 2.0 | 0.5 | 39 |
| | After | 0.10 | 166 | 129 | 29 | 4.5 | 2.2 | 1.5 | ..... |
| 2. 40 lb/A 2,4-D ester | Before | 0.30 | 144 | 111 | 20 | 5.8 | 3.2 | 1.2 | 3 |
| | After | 0.19 | 358 | 312 | 40 | ..... | ..... | 5.0 | 1 |

All of the population changes noted above appear to be normal, seasonal fluctuations. Since changes in the control plot were similar to changes in the experimental areas, there are no data indicating that 2,4-D had a deleterious effect upon the bottom fauna. However, there was little difference in the amount of weed growth on the control and experimental plots during the summer following this treatment. Hence, there is little or no evidence that the lake bottom received the dosage of chemical that was applied to the ice, and failure to note changes in the benthos population is not conclusive evidence that 2,4-D pellets, in the concentration used, are harmless to fish-food organisms. Further tests should be made to determine whether or not the pellets retain their 2,4-D while passing through the ice and water to the lake bottom.

[1] Institute for Fisheries Research, Michigan Department of Conservation, Ann Arbor, Michigan.

[2] A New Approach to the Control of Certain Aquatic Vegetation. Proc. 13th North Central Weed Control Conf., pp. 30-31.



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# PRESENTATION OF AWARDS

**Professor Keith E. Wallace of South Dakota State College announced that the winner of the 1958 Essay Contest was Stuart Myers, age 14, R. D. No. 1, Madison, South Dakota. This paper follows.**

## HOW WE CONTROL WEEDS ON OUR FARM

**Stuart Meyers**

Weeds cost American farmers about five billion dollars a year. From 10 to 30 percent of a crop's value often goes into the fight against weeds. Weeds make harder work for the farmer, lower his crop yields, contaminate his seed, deprive his livestock of feed, occasionally poison his animals and generally make his life miserable.

The first thing we did in controlling weeds was to contact our County Weed Board or County Agent to obtain information on the newest and best way to control the newer kinds of weeds and some of the older types that were still giving us trouble on our farm. Then we could watch for them and control them before they got a start.

In the spring we disk the cornstalks two or three times before seeding the small grain, then drag after it is in the ground. This helps to control small weeds until they are big enough to spray. Fall plowing is disked once or twice and dragged once before the corn is planted, then dragged another time or two. This helps control the small weeds until the corn is big enough to cultivate.

We are careful to plant only clean seed, as one of the most common ways of spreading weeds is through dirty crop seed. We check the tags on our seed bags to be sure we're planting pure seed. Certified seed is the best bet. If seed prices seem high, we can blame much of it on weeds as the biggest single task in preparing seed. If we use our own seed grain it is run through a fanning mill to remove weed seeds and other foreign matter. We test seed for germination, as a good hardy seed has a better chance of getting a start ahead of the weeds. Weeds grow faster than most of the crops they infest.

Grain crops are sprayed before they head out to prevent decreasing the yield, and to kill the weeds that have come up with the crop. We use 2,4-D ester or amine types. When the grain is ready to harvest we cut the weed patches separately and do not run them through the combine as that spreads the weed seeds through the field. We make sure that the equipment we use in planting and harvesting is clean, as it is easy to contaminate seed grain with weed seeds left in a combine. Grain heavily polluted with weed seed brings a lower price to cover the cost of cleaning, and sometimes it isn't even salable.

Stubble fields are sprayed for noxious weeds as soon as combining is completed, and plowed early in the fall to keep any remaining weeds from going to seed and spreading.

We cultivate our corn 3 times. This is very necessary to control weed growth. Right after we cultivate for the second time we spray the corn for any weeds that we missed with the cultivator. We also spray along the fence lines to eliminate those weeds from seeding and spreading through the fields.

If soybeans are grown in rows one can easily lose 10% of the crop to weeds. We rid the field of these by getting out and pulling them when they're little and easy to pull. If we don't get them pulled, we have found that the best way of getting rid of weeds, such as sunflowers, is to go out with corn knives and cut them off close to the ground right after they blossom out.

On our farm we have quite a lot of trouble controlling the buffalo bur and Canada thistle. Sodium chlorate and borax are chemicals that are effective in eradicating small areas. We have found that the best way of keeping the small patches of buffalo bur from spreading is to spray them with 2,4-D mixed with fuel oil. Buffalo bur can also be controlled if disked, plowed or pulled before seed is produced. Tall plants may be mowed off to prevent them from seeding. Small plants must be hoed or dug out. It is highly resistant to the ordinary solution of 2,4-D. To kill small patches of Canada thistle in a grain field, we spray with 2,4-D mixed with fuel oil right after harvesting the crop. Another way is to plant a smother crop, such as alfalfa. That way the alfalfa will smother out the thistles. Cutting the hay 2 or 3 times a year keeps the thistle from blooming and seeding.

We also clip the weeds in our pasture before they have gone to seed. This is an especially good measure against the spread of pasture thistles. In our pasture we have a slough that is usually infested with cocklebburs. This fall we plan on plowing it up and then seeding it down to grass sometime later on.

Once in a while we are also troubled with creeping jenny. For this we spray with 2,4-D after it starts to flower. In small grain fields, we treat when the grain is in the dough stage. In corn fields, we use a spray gun or hand sprayer in July or August. We have killed it with intensive cultivation which starves the root system and also by soil sterilant chemicals. We have found that the most successful way of controlling weeds on our farm is by good, deep plowing and cultivation. Also by spraying with the right chemical at the right time in order to get the best kill of the weed.

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**Mr. Maurice B. Turner, Amchem Products, Inc., Chairman of the Industry Division, announced the winners of the award for County Extension worker and for County Regulatory worker in the North Central region. The winners of both awards were from the Province of Alberta. The winner of the extension award was Mr. Robert C. Moffat, County Extension worker in Construction County. The winner of the county weed worker award was George W. Philpott, Newell County, District No. 4, Alberta. Summaries of their reports follow.**

Mr. Moffat's most important activity was his promotion, publicity, and organization of the Construction County Seed Cleaning Plant, the first in the Peace River country, which cost $48,000. He assisted the Experimental Farm in setting out field trials on mayweed, quackgrass, and wild oats, and personally conducted an experiment on the eradication of toadflax. He participated in roadside mowing, seeding, and brush spraying and in a roadside mayweed control program. He held 28 meetings with a total attendance of over 800 and conducted 17 tours with an attendance of over 200. Eight method demonstrations were conducted with 340 in attendance and 23 result demonstrations were established. Four training schools were held and 7 exhibits or displays were prepared and shown. In addition 22 news stories and 9 radio programs were given. Thirty-four groups and 144 individuals were contacted on weed control problems. Forty-five 4-H members carried out weed control projects.

In previous years, Mr. Moffat had conducted seed-drill surveys, held two seed fairs, conducted an extensive weed identification service, supervised weed inspection activities in improvement districts, assisted in the distribution of 12,000 bushels of seed in 1957-58, and had the provincial champion 4-H oat plot in 1957.

Mr. George W. Philpott is the Weed Commissioner for Newell County, Alberta, and has held this position for 5 years. His work is supervised by the Agricultural Service Board. He spent 270 days on regulatory and enforcement activities, making 3,260 calls. He sent 157

notices to destroy weeds and caused 109 letters to be sent by the county attorney. However, no court cases were held and only on 11 farms was it necessary to destroy the weeds and put the charges on the tax rolls. He helped spray over 1,000 acres of crops, nearly 1500 miles of roadside, and over 1500 miles of railroad and public utility rights-of-way. He prepared 49 newspaper articles and 22 weed exhibits. He cooperated with over 100 other agencies interested in weed control. His personal statement, which concluded the form, is as follows:

"Visited four nearby municipalities regarding weed control—gave and demonstrated methods and procedures in obtaining successful results in weed control. Instructed three weed inspectors employed by the county in basic weed control methods and handling farmers and planned and supervised their work.

"38,150 lb of 2,4-D and 5,150 lb soil sterilants were distributed to farmers in the county. There were 1.200 lb of sterilants used by myself and my staff, and seven new and promising herbicides tested.

"72 miles of county roads were back-sloped and sown to grass and 634 miles of county highways were mown. By special arrangement, 71 miles of Provincial Highways were sprayed and 30 miles mown and the hay baled.

"Special complimentary letters were sent to 92 farmers who cooperated in freeing their fields of severe weed infestations.

"A special conference was held with Indian authorities in regard to serious noxious weed infestations on the reservations adjoining our western border. Planned and estimated their cost of a cleanup program for 1959. Instrumental in their passing a special Bylaw to cope with the serious situation. Put machinery in motion to obtain Federal Government and other assistance. Was instrumental in encouraging and assisting in weed competitions in 14 schools.

"The reason for good success obtained to date has been the co-ordinating of all interested and responsible organizations—the County, Department of Agriculture, Railroads, Irrigation Company, Department of Public Works, Agricultural Service Board and the Farmers Union. I advise the Service Board of all major problems, suggest remedies, and persuade them to use all applicable Provincial Government grants and other assistance for weed control and soil conservation work, being guided by the policies established by both the Provincial and the County Governments.

"I like my work and use every opportunity to build up weed consciousness in the county."

---

**Dr. Neal E. Shafer of the University of Nebraska, Chairman of the Committee on Honorary Membership, introduced Dr. L. W. Melander as an Honorary member for 1958, and presented him with a scroll. He also announced a posthumous award of an Honorary Membership to Dr. Thomas K. Pavlychenko. His remarks follow.**

It is a distinct pleasure at this time to honor a man who has been active in weed control work for many years. Our recipient this year was born at Red Wing, Minnesota, October 21, 1893. After graduation from Red Wing High School in 1912, he attended the University of Minnesota College of Agriculture where he was graduated in 1921. The years beginning in 1920 were important ones for our candidate for it was at this time that he started a career with the U. S. Department of Agriculture that was to cover a span of 35 years. While carrying out some of the important early work on the control of stem rust of wheat, oats, barley and rye he continued working towards advanced degrees. As a result of this continued effort he received the degree Master of Science in 1924 and the degree Doctor of Philosophy in 1930, both from the University of Minnesota.

His first experiences in weed control began in 1920 with the recognition of the need for barberry eradication in wheat stem rust control. At that time complete removal of the plant by digging was the accepted method. Shortly after his appointment he began a search for chemical methods that would improve effectiveness and enhance efficiency. This led to the widespread use of salt for many years. Later he developed the use of ammonium sulfamate for the same purpose. Along with his duties with the U. S. Department of Agriculture, he was also appointed State Leader of barberry eradication, beginning in 1920. He assisted in hundreds of county weed meetings in Minnesota during the early years following enactment of the Minnesota Weed Control law. He helped stress the importance of barberry and other noxious weed eradication and was instrumental in promoting a favorable public sentiment toward this newly enacted legislation.

In 1945, he was officially assigned to research with herbicides for killing the native barberries found in the North Central States and the adjacent states of Montana, Wyoming, Colorado, Pennsylvania, Virginia and West Virginia. Extensive studies were carried out with 2,4-D, 2,4,5-T, MCPA, and other hormone type herbicides. Numerous reports and publications have been compiled giving results of these investigations. He has been a devoted worker in the North Central Weed Control Conference, having been in attendance at all meetings starting in 1945. He was a member of the original committee that inaugurated the practice of publishing abstracts of experimental work, which has made our present Research Report one of the most valuable publications of our North Central Weed Control Conference. For five years he served as chairman of the woody plant control subcommittee. Under his forceful and enthusiastic guidance this section of NCWCC grew to become one of the most interesting and most widely attended portions of our conference. Extensive lists were prepared each year showing the known response of large numbers of woody plants to herbicidal treatment. The compilation of data, the preparation of summaries and species responses, and the stimulating discussion periods all mark this section as a model for coordinated research on a regional basis.

In 1954, after 35 years in the U.S. Department of Agriculture, he retired for a brief time. Still only 60 years old, he accepted a position in agricultural chemical development with the American Chemical Paint Co. now known as Amchem Products Inc. His two principal projects have been development work with amino triazole and with other herbicides in the timber and pulp industries. He has remained active in the field of woody plant control with publications on the herbicidal effects of amino triazole on poison ivy, buckbrush, and prickly ash. He has directed much effort toward the use of chemicals for plantation release in forest management, for bark separation, and for weed control in forage nurseries. He has worked closely with State Conservation Divisions in controlling cattails and *Phragmites*. In October 1958, he retired from this position.

He is a member of various scientific and honorary societies including Alpha Zeta, American Association for the Advancement of Science, Weed Society of America, and a life member of the American Phytopathological Society.

In view of his many years of service and the important contributions he has made in the control of woody plants and his early and continued efforts for the North Central Weed Control Conference, Dr. Leonard W. Melander is hereby awarded an Honorary Membership in the North Central Weed Control Conference. It is a distinct pleasure and privilege to present this scroll on behalf of the North Central Weed Control Conference and to offer congratulations on a job well done.



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The untimely passing of Dr. Thomas K. Pavlychenko on August 4, 1958 brought to a close the career of a man whose contributions in the field of plant ecology and weed control have been truly outstanding. It is a special privilege to award him an Honorary Membership in the North Central Weed Control Conference as a further token in recognition of his years of dedicated work and remarkable achievements. It is most regretable that the benefit of his knowledge and wide experience, always so freely shared, will no longer be available to the members of this group.

Dr. Pavlychenko was born in the Ukraine on March 7, 1892 and was educated at the Pedagogical Institute, Vinnetza. During the years 1909-1912 he studied at the College of Agriculture, Kamenetz-Podilsky, also in the Ukraine. A scholarship award permitted him to take advanced studies in Czechoslovakia in the years 1922-1926. During the period from 1929 to 1932 he obtained the Master of Science degree in Agriculture from the University of Saskatchewan and further study, with the aid of a research fellowship from the Carnegie Corporation of New York, led to his receiving the Doctor of Philosophy degree from the University of Nebraska in 1940.

In 1938 Dr. Pavlychenko established the Department of Plant Ecology at the University of Saskatchewan, which was the first of its kind in Canada. This appointment made him the first Professor of Ukrainian descent in Canada and his Ukrainian courses at the University of Saskatchewan resulted in the establishment of a Slavic department there. He headed the Department of Plant Ecology until 1948 and it was during this time that he made his classical contributions to our knowledge of the root systems of many of our weed and crop species. His work developed various new quantitative methods of analyzing plant root systems as well as their development. This not only gave much needed fundamental information but also contributed greatly toward our concepts of shallow tillage for controlling weeds. His many research papers on this work have been published in the journals of numerous North American agricultural scientific societies and have been widely quoted in text books and scientific periodicals throughout the world.

With the release of systemic or hormone type herbicides in 1945 he devoted a large part of his energies to investigating the many aspects of selective weed control. Here again he made many notable contributions. He was an active member of many agricultural and scientific societies. He was not only an active member of the National Weed Committee (Western Section) of Canada but also was one of the chief organizers of the First Western Canadian Weed Control Conference, held in Regina, Saskatchewan, in 1947. He has also been an active member of the North Central Weed Control Conference since its inception and has served as a Director of this group.

Other societies in which Dr. Pavlychenko was a member were the Saskatchewan Field Husbandry Association, Western Canadian Society of Agronomy, the Agricultural Institute of Canada, American Association for the Advancement of Science and the Ecological Society of America.

In 1948 Dr. Pavlychenko left the University of Saskatchewan to take a post as research director with the American Chemical Paint Co., now Amchem Products Inc. Although in the employ of this company in an advisory capacity, he did not give up active research in weed control, maintaining an experimental area near his office at Saskatoon, Sask. As a mark of recognition of the quality of his work he was invited to tour Australia and Japan by the governments of those countries to lecture and give advice on weed control to farmers and agricultural groups. In his last years he was in the process of writing a book covering his work with the root systems of plants and and his new quantitative methods of analyzing the studying of them. The book was to have been published and distributed on a world wide basis.

The posthumous presentation of this scroll on behalf of the North Central Weed Control Conference to Dr. T. K. Pavlychenko is indeed a fitting tribute to a man of outstanding achievements who gave many years of dedicated service to agricultural research.

## HONORARY MEMBERS NORTH CENTRAL WEED CONTROL CONFERENCE

These are the Honorary Members of the NCWCC. The first one was chosen in 1948.

| | |
|---|---|
| 1948 | L. W. Kephart |
| 1949 | A. H. Larson |
| 1950 | J. Walter Zahnley |
| 1951 | Posthumous citations of T. R. Yost and R. F. Fuelleman |
| 1952 | Henry E. Wood |
| 1953 | Walter C. Dutton, George Briggs |
| 1954 | A. L. Bakke |
| 1955 | C. J. Willard |
| 1956 | R. S. Dunham |
| 1957 | P. J. Olson |
| 1958 | L. W. Melander and posthumous citation of T. K. Pavlychenko |

# RESOLUTIONS

## NORTH CENTRAL WEED CONTROL CONFERENCE INC.

### 1958 Cincinnati, Ohio

WHEREAS, the passing of Dr. Thomas K. Pavlychenko has deprived the entire weed control program of a competent and valued worker, and WHEREAS, we individually, and as a Conference organization will miss him and his support of our work,

THEREFORE, BE IT RESOLVED, that we express our deep regret at his passing and extend to his family and close business associates our deepest sympathy; and be it further resolved that this resolution be placed in the minutes of this organization and the Secretary be instructed to transmit to his family and to Amchem Products Inc., copies of this resolution.

WHEREAS, the NCWCC appreciates the arrangements that have been made and the excellent facilities provided for this 15th Annual Meeting NOW, THEREFORE, BE IT RESOLVED that we express our thanks to the State of Ohio, the City of Cincinnati, the Staff of The Ohio State University and particularly to Dr. C. J. Willard and Dr. E. K. Alban of the local arrangements committee, and to the Midwest Farm Paper Unit for providing the attractive program.

Furthermore, BE IT RESOLVED that this Conference express its thanks to all others who have participated in making this Conference program a success.



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## Meetings of the Board of Directors

## Netherland Hilton Hotel, Cincinnati, Ohio

## Abstracts of the Minutes

## December 2, 1958

President Derscheid called the meeting to order at 8:15 p.m.

The Treasurer's report was read by John D. Furrer. It showed ordinary income, aside from principal of maturing investments, of $4318.61 from November 9, 1957 to November 15, 1958. Ordinary disbursements for the same period were $5068.61. The cash on hand November 14, 1958 was $3428.29 and $13,950 was invested in U. S. Savings Bonds, Series E and F, and U. S. Treasury Notes. $1925 of the receipts came from industrial memberships.

The Industrial Chairman was extended a note of appreciation for his excellent work.

The Committee on Local Arrangements reported that everything was progressing satisfactorily.

The Committee on Annual vs. Biennial meetings, Oliver C. Lee, Chairman, reported that five of the seven Committee members favored biennial meetings starting after the St. Louis meeting in 1961. The report was referred to the new Board of Directors.

The Committee on Location of Future Meetings, G. F. Warren, Chairman, recommended that the Conference meet in St. Louis in December, 1961, or in January, 1962, when the NCWCC is host to the Weed Society of America. The 1959 meeting is scheduled for Winnipeg, Manitoba, and the 1960 meeting for East Lansing, Michigan. It was moved and carried that the NCWCC invite the Weed Society of America to meet in St. Louis in December 1961.

The Committee on Publications, C. J. Willard, Chairman, reported that plans were in process to print the Research Report and Research Summaries with the Proceedings.

The Extension Committee, Don Peterson, Chairman, reported there were only three entries submitted out of a possible 17 for the County Extension Service Award.

The Regulatory Committee, Howard T. Richards, Chairman, reported that only four entries were submitted for the County Regulatory Award. Mr. Richards reported on the meeting of the North Central Weed Control Officials at Purdue which he was authorized to attend as a representative of the NCWCC. It was moved and carried that the NCWCC work with Weed Control officials in attempting to bring more uniformity in noxious weed seed lists and that a member of the Regulatory group be authorized to meet with the joint legislative committee of that group.

Mr. Lobay reported that R. C. Moffat, Grand Prairie, Alberta, had received the Extension Award and that George W. Philpott, Brooks, Alberta, had received the Regulatory Award.

The Committee on Honorary Membership, Neal Shafer, Chairman, recommended making two awards in 1958, one to Dr. L. W. Melander and a posthumous award to Dr. Pavlychenko.

It was moved and carried that the NCWCC pay the expenses to the meeting of the individual receiving an honorary membership.

The Committee on Nominations, F. W. Slife, Chairman, submitted the following nominations: Secretary-Treasurer, John D. Furrer; Vice-President, L. G. Holm; President, J. Roe Foster. Each of these nominations was submitted individually to the Board and the men elected to the offices named.

It was moved and seconded that the retiring Secretary-Treasurer be voted an honorarium and a letter of appreciation from the President for his fine work.

Under new business it was moved and carried that a committee of five be appointed by the new officers to revise the NCWCC Constitution with special emphasis on making the NCWCC a membership organization.

## December 3, 1959

The Board of Directors was called to order by President Foster at 5 p.m. President Foster appointed the following committee to revise the Constitution of the Conference: K. P. Buchholtz, Chairman, D. W. Staniforth, M. B. Turner, John Hutchinson and Oliver C. Lee.

The Research Committee, D. D. Hemphill, Vice-Chairman, reported that the Committee had compiled a report, "Research Summaries," of which 1000 copies had been mimeographed and were being distributed. Considerable discussion of the future nature of this report followed. A committee had been appointed to study the activities of the Research Committee during the years that the Conference does not meet.

The Extension Committee, Don Peterson, Chairman, submitted a lengthy formal report concerning the revision of the Constitution, the Research Summaries, and the 1961 program.

The Regulatory Committee, H. T. Richards, Chairman, reported that officers for the Regulatory Committee for 1959 are: Howard T. Richards, Wisconsin, Chairman, Sig Bjerken, Minnesota, Vice-chairman, and K. L. Blanchard, Minnesota, Secretary. He made a lengthy formal report concerning the relations of the Regulatory group to the other members of the Conference and referred to a possibility that the Regulatory members would form a separate organization.

The Industry Representative, Mr. M. B. Turner, reported that he would serve for another year as Industry Representative. He presented a lengthy formal report which emphasized the concern of the Industry members over the apparent failure of weed control recommendations to reach farmers.

The Committee on Annual vs Biennial meetings, Oliver C. Lee, Chairman, reported that 6 of the 7 members had now voted for biennial meetings with the Chairman abstaining. It was moved and carried that the North Central Weed Control Conference begin biennial meetings in 1963, following the 1962 meeting. A meeting was to be held in 1962, following the St. Louis meeting, in order that the years when the NCWCC met would alternate with the years when the Weed Society of America met.

The Essay Committee, Keith Wallace, Chairman, reported that Stuart Meyer of Madison, South Dakota was selected as the NCWCC Essay Contest winner for 1958.

Under new business it was moved and carried that the Proceedings of the NCWCC include edited copies of the Director's meetings and Financial Report.

The Committee on Resolutions and Necrology, B. H. Grigsby, Chairman, presented suggested resolutions. The resolutions as printed elsewhere in this Proceedings were adopted.

It was definitely announced that the 1959 meeting will be on December 9 and 10 at Winnipeg, Manitoba. The headquarters is to be the Royal Alexandra Hotel. The Western Canadian Weed Control Conference will meet there December 7 and 8.



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# RESEARCH SUMMARIES

**Prepared by the Research Committee**

**NORTH CENTRAL WEED CONTROL CONFERENCE**

## FOREWORD

The information presented in this report has been prepared by the Research Committee of the North Central Weed Control Conference and represents the combined efforts of a majority of the research workers in the Conference area. As a result of action taken at the 1956 and 1957 Research Committee meetings, the compilation of recommendations or suggestions has been discontinued. The present report has been prepared in place of recommendations. In essence the research summaries presented here are expanded and more complete versions of those summaries which in past years have preceded the research abstracts printed in the annual Research Report. This year the summaries include the important advances in weed control techniques observed and experienced in the North Central Region during the period 1945 to 1958, and retain certain aspects and portions of the "Recommendations or Suggestions" of previous years. The Research Committee anticipates that the preparation of these relatively detailed and complete summaries at this time, may facilitate in future years the development of research summaries which will include only the research reported during the period between successive meetings of the Conference.

This material is presented primarily as background information for persons responsible for making recommendations for the control of weeds and is not intended to be used as definite recommendations for the Conference area as a whole. This limitation is desirable because it is recognized that climate and other factors which affect weed control vary from region to region. *These suggestions, therefore, do not take the place of state and local recommendations. Specific recommendations should be obtained from experiment station, extension service or other qualified source.*

*The use of chemicals suggested in this report, is contingent upon registration by the United States Department of Agriculture and/or establishment of residue tolerances where necessary by the United States Department of Health, Education and Welfare.* Chemicals should be used only as recommended on the labels. Persons making recommendations for uses beyond those indicated on the label may be held liable.

The rates of application given for 2,4-D, MCPA, 2,4,5-T, dalapon, and other phenoxy compounds are on the basis of acid equivalent; the rates of PCP, and DNBP refer to the phenol equivalent and the rates of PMA, IPC, CIPC, monuron, MH, SES, NP, KOCN, and others refer to the active ingredients.

Research Committee,

North Central Weed Control Conference
David W. Staniforth, *Chairman*
Delbert D. Hemphill, *Vice-Chairman*



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## RESEARCH COMMITTEE NCWCC, 1958

| | |
|---|---|
| **R. N. Andersen** | Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, Minn. |
| **L. E. Anderson** | Department of Agronomy, Kansas State College, Manhattan, Kansas |
| **R. H. Beatty** | Agricultural Chemicals Research, Amchem Products Inc., Ambler, Penna. |
| **K. P. Buchholtz** | Department of Agronomy, University of Wisconsin, Madison, Wisconsin |
| **W. H. Daniel** | Department of Agronomy, Purdue University, Lafayette, Indiana |
| **J. H. Davidson** | Agricultural Chemicals Development, The Dow Chemical Company, Midland, Michigan |
| **L. A. Derscheid** | Department of Agronomy, South Dakota State College, Brookings, South Dakota |
| **H. M. Elwell** | Crops Research Division, ARS-USDA, Department of Agronomy, Oklahoma State University, Stillwater, Oklahoma |
| **O. H. Fletchall** | Department of Field Crops, University of Missouri, Columbia, Missouri |
| **H. A. Friesen** | Experimental Farms Service, Experimental Farm, Lacombe, Alberta, Canada |
| **G. F. Friesen** | Department of Plant Science, University of Manitoba, Winnipeg, Manitoba, Canada |
| **B. H. Grigsby** | Department of Botany and Plant Pathology, Michigan State University, East Lansing, Michigan |
| **H. L. Hansen** | School of Forestry, University of Minnesota, St. Paul, Minnesota |
| **E. A. Helgeson** | Department of Botany and Plant Pathology, North Dakota State College, Fargo, North Dakota |
| **D. D. Hemphill (Vice-Chairman)** | Department of Horticulture, University of Missouri, Columbia, Missouri |
| **L. G. Holm** | Department of Horticulture, University of Wisconsin, Madison, Wisconsin |
| **O. C. Lee** | Department of Botany and Plant Pathology, Purdue University, Lafayette, Indiana |
| **W. E. Loomis** | Department of Botany and Plant Pathology, Iowa State College, Ames, Iowa |
| **W. G. Lovely** | Agricultural Engineering Research, ARS-USDA, Department of Agricultural Engineering, Iowa State College, Ames, Iowa |
| **J. P. Mahlstede** | Department of Horticulture, Iowa State College, Ames, Iowa |
| **M. K. McCarty** | Crops Research Div. ARS-USDA., Department of Agronomy, University of Nebraska, Lincoln, Nebraska |
| **R. E. Nylund** | Department of Horticulture, University of Minnesota, St. Paul, Minnesota |
| **W. M. Phillips** | Crops Research Division, ARS-USDA, Fort Hays Experiment Station, Hays, Kansas |
| **S. K. Ries** | Department of Horticulture, Michigan State University, East Lansing, Michigan |
| **R. G. Robinson** | Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, Minnesota |
| **P. F. Sand** | Department of Agronomy, University of Nebraska, Lincoln, Nebraska |
| **J. J. Sexsmith** | Experimental Farms Service, Experimental Farm, Lethbridge, Alberta, Canada |
| **N. E. Shafer** | Department of Agronomy, University of Nebraska, Lincoln, Nebraska |
| **F. W. Slife** | Department of Agronomy, University of Illinois, Urbana, Illinois |
| **E. P. Sylwester** | Department of Botany and Plant Pathology, Iowa State College, Ames, Iowa |
| **D. W. Staniforth (Chairman)** | Department of Botany and Plant Pathology, Iowa State College, Ames, Iowa |



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## CONTROL OF HERBACEOUS PERENNIAL WEEDS

### JOHNSONGRASS[1]

**O. Hale Fletchall**

**Cultural Control.** Clean cultivation has proved the most practical method of controlling extensive infestations of Johnsongrass. Heavy pasturing, frequent clipping or a combination of the two will reduce stands. One or two years of continuous close defoliation preceding clean cultivation increases the effectiveness of the clean cultivation treatment. An effective procedure for clean cultivation is to plow the land about 4 to 6 inches deep in June and thoroughly till the land to bury the tops or to sever them from the underground portions of the plant as frequently as the re-growth reaches a height of about 6 inches. After the first year, tillage should begin in the spring when the Johnsongrass is about 6 inches tall. Each year, it should continue until growth is stopped by cold weather. Good control of established plants has been obtained with one or two years of clean cultivation by this method. With somewhat slower progress, small grain can be produced on the land with plowing and clean tillage applied from harvest time until cold weather stops growth or until time to plant small grain in the fall. Growing alfalfa on Johnsongrass infested land results in good quality mixed hay and the frequent cutting weakens the Johnsongrass and prevents seed production. Competition from alfalfa does not eradicate Johnsongrass. When corn is grown on Johnsongrass infested land, checking and cross plowing help to keep the Johnsongrass under control.

Johnsongrass seed remains viable in the soil for several years and some of it germinates each year. The seedlings start to produce rhizomes 3 to 6 weeks after emergence and they produce seed heads at 10 to 12 weeks of age. An effective control program must include seedling control by cultivation or herbicides.

**Chemical control.** Several herbicides have proved effective for treating scattered plants that survive cultural control methods, small patches of Johnsongrass on cultivated land, and for Johnsongrass control on non-cultivated land. Effective treatments are sodium chlorate, 3 to 5 lb/sq rd (480 to 800 lb/A); TCA[2] ⅜ to ⅝ lb/sq rd (60 to 100 lb/A); monuron, on non-crop land only, at ¼ to ½ lb/sq rd (40 to 80 lb/A); a boron-chlorate mixture containing at least 20% sodium chlorate 6 to 9 lb/sq rd (960 to 1440 lb/A); and dalapon at rates of ⅛ to ¼ lb/sq rd (20 to 40 lb/A) in the western part of the region to ¼ to ⅜ lb/sq rd (40 to 60 lb/A) in the eastern part of the region. Recent research indicated that erbon at ½ lb/sq rd (80 lb/A) gave satisfactory control of Johnsongrass. The erbon sterilized the soil for at least one year.

Dalapon at 10 to 12 lb/A applied in the spring when the Johnsongrass was about 10 inches tall followed by plowing about a week after spraying gave good results in limited tests. Two or three light applications at approximately one week intervals appeared to give slightly better control than a single treatment at a rate equal to the total of the split applications.

Dalapon at ⅛ lb/gal of water applied as a wetting spray was satisfactory for spot treatment of scattered Johnsongrass plants. Two to four treatments 1 to 3 weeks apart were effective for control of scattered plants in cultivated crops.

EPTC at 3 to 4 lb/A incorporated in the top 2 to 4 inches of soil gave good Johnsongrass seedling control.

Crown oiling to kill established Johnsongrass plants in crops has been tested using naphtha, kerosene, diesel oil, and mixtures of these. Reports of recent research show good results from fortifying the oils with about 0.25 gal and with 2 gal of HCA per 100 gal of oil. Good results also were obtained by fortifying the oil with 0.5 gal and with about 10 gal of hexachlorocyclopentadiene (C-56) per 100 gal of oil. In each case 3 applications were made during the season.

Ten lb/A of dalapon gave a greater reduction in Johnsongrass bud sprouting soon after treatment than 20 lb/A of dalapon, 140 lb/A of HCA or 20 lb/A of 2-methoxy-4,6-bis(isopropylamino)-*s*-triazine (G-31435). This may have been because of less leaf injury.

[1] For Latin names of all weeds, see the Index of Weeds, Crops, and General Index.

[2] For full chemical names of chemicals for which standard abbreviations have been established, see Index of Chemicals.

### QUACKGRASS

**K. P. Buchholtz**

Quackgrass is a persistent perennial weed found throughout the northern states and Canada. It grows under a variety of conditions and in many crops. Due to its wide geographical range a number of control measures have been developed. The particular control measure to use in any instance can be determined only after a consideration of many factors.

Cultural control methods usually are the most economical on large infestations. Tillage may be utilized to bring rhizomes to the surface where they may be dried out, or it may destroy shoots of the quackgrass and so gradually reduce the food reserves of roots and rhizomes. In some instances control can be obtained by competitive cropping. When infestations are more limited in area chemical applications may be useful. Various cultural methods and chemical applications are often used in combination.

**Tillage.** In the drier portions of the region roots and rhizomes are readily killed by drying on the soil surface. To accomplish this, tillage with a heavy duty spring-toothed cultivator shoud be at a depth of only 3 or 4 inches. The shovels of such an implement should have a spring shank and have teeth only 1 or 2 inches wide. The implement should be operated at a slightly lower depth for each successive cultivation. A wire or cable cultivator is used in some areas to bring rhizomes to the surface of the soil after they are loosened by the spring-toothed implement. If the area has been plowed it may be necessary to cut up the sod with a heavy disk to prevent clogging. The first operation should start in July when drying conditions are good. Succeeding cultivations should occur at intervals of about 1 week even though no growth of the quackgrass is apparent. It is important that the maximum number of rhizomes are brought to the surface where they will be dried out.

A one-way disk, double disk, or cultivator equipped with sweeps is a suitable implement for destroying the shoot growth of the quackgrass. A one-way disk or double disk has the advantage of not spreading the rhizomes about the field when the infestation occurs only in patches. Quackgrass should never be allowed to make more than 2 or 3 inches of top growth between cultivations. Tillage to destroy the top growth also exposes the rhizomes to drying to a limited degree.

Shallow cultivation or plowing in the late fall exposes the rhizomes to freezing and drying over winter and reduces the stand and the rapidity of spring growth. Intensive grazing before cultural operations are started is beneficial since it weakens the sod and makes tillage easier.

Clean cultivated row-crops are very useful for controlling quackgrass. If quackgrass is weakened before the crop is planted, it is possible to continue to reduce the infestation by frequent cultivation during spring and summer months. The use of checked corn is especially effective for tillage may be done in two directions when the crop is planted in this manner. Quackgrass from patches may be spread about the field if rhizomes cling to the shovels of tillage implements.

**Competitive crops.** To be most effective competitive crops should be planted only after the quackgrass has been partially subdued by tillage. A closely drilled stand



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of soybeans will be effective when sown in the late spring and when a vigorous growth of beans develops. In some areas vigorous closely drilled stands of Sudan grass, sunflowers or buckwheat may be used for this purpose. In gardens a relatively close spacing of squash or pumpkins is useful for these plants make a dense leaf growth and are effective competitors during the summer and fall months.

**Chemical control.** Chemical control measures reduce the need for frequent cultivations, may be more convenient and in some instances are no more expensive than tillage. The effectiveness of chemicals is strongly influenced by climate, soil and cropping sequences. For best results all suggested applications should be modified to conform to local conditions.

**TCA.** Application, preferably to bare soil, of from 20 to 40 lb/A of TCA during the late summer or early fall will control quackgrass in humid regions when the application is preceded or followed by a thorough tillage or plowing. Elsewhere from 40 to 80 lb/A are required. From 80 to as much as 240 lb/ of TCA are required in sub-humid areas for the control of weeds in an untilled sod. Fall applications of the heavier rates of TCA are likely to leave a soil residue detrimental to production of sensitive crops during the next growing season. Plentiful moisture, drainage and warm soil temperatures are required to eliminate the residue of TCA in the soil.

**Dalapon.** This chemical is most effective when applied to quackgrass with a fair growth of foliage from 4 to 8 inches tall. In humid areas fall treatments of 10 lb/A followed by plowing or other soil tillage before freeze-up will give good control of quackgrass the following year. Rainfall after treatment but before tillage improves the control obtained. In less humid areas from 15 to 20 lb/A of chemicals will be required. Repeated treatments will be necessary for eradication. Crops sown in the spring on areas treated early in the fall usually are not affected if normal, or above normal, rainfall occurs during the fall, winter or early spring.

Dalapon may also be applied to quackgrass infested areas in the spring. An application of from 4 to 8 lb/A when the grass has leaves from 2 to 6 inches tall, is most satisfactory in humid regions. In less humid areas 15 lb/A will be required. The treatment should be followed in 2 or 3 weeks by plowing or some other form of soil cultivation. Light rainfall soon after treatment improves the kill of quackgrass obtained. Spring applications will injure sensitive early-seeded crops. As a precaution such crops should not be planted until 4 weeks have elapsed after the application. Favorable soil moisture and warm soil temperatures are needed to eliminate the residue of dalapon in the soil. Corn, wheat, barley, soybeans and other types of beans are especially sensitive to small amounts of dalapon remaining in the soil.

A single application of 10 lb/A of dalapon in the early spring will give seasonal control of quackgrass in areas that cannot be cultivated but some damage to shrubs or trees may result. Two applications of 5 lb/A with an interval of 6 weeks will control the growth of quackgrass under mature fruit trees, poplar and some other species in shelter belts. Dalapon should not be used under young cherry and peach trees or Caragana in shelter belts.

**Amitrol.** This chemical should be applied at about 4 lb/A when the quackgrass has good growth of new foliage but before heading has occurred. Applications may be made in either the spring or fall. Thorough tillage or plowing 2 or 3 weeks after treatment is essential for good control. Best results occur on fertile soils or following fertilization of quackgrass with nitrogen to ensure a dense shoot growth. Crops may be planted as soon as soil preparation is completed for amino triazole leaves little or no toxic residue.

**Maleic hydrazide.** This chemical is most useful in garden areas. In humid regions effective control of quackgrass can be obtained by early spring applications of 4 lb/A of maleic hydrazide. When applications are made in dry areas, or during periods of low humidity, this material will provide little or no control of quackgrass. The quackgrass should have a dense growth of foliage at time of treatment. On soils low in fertility an application of nitrogen will improve shoot growth and result in better control of the weed. It is essential that the treated areas be spaded or plowed under 4 to 8 days after the application of the chemical. Delay in tillage will reduce the control obtained. Crops may be planted on areas treated with maleic hydrazide immediately after soil preparation for no toxic residue is left in the soil.

**Soil sterilants.** Sodium chlorate may be applied at any time, although probably to better advantage in the fall when rainfall is moderate, at from 2 to 4 lb/sq rod (320 to 640 lb/A). In drier areas as much as 6 lb/sq rd may be required. In sub-humid regions such applications of sodium chlorate are likely to leave a residue toxic to crop growth during several growing seasons. Monuron may be used for eradicating quackgrass on non-crop land. Complete or nearly complete kills are obtained by applying 20 to 40 lb/A. Early spring or late fall treatments are the most effective. Normal growth of crops on the treated areas should not be expected for several years. Where rainfall is plentiful simazin will eliminate quackgrass when applied at from 10 to 20 lb/A. In areas of low rainfall simazin is likely to give little or no control. Fall or early spring treatments are most satisfactory. In all cases the kill of the weed will be quite slow. The soil will retain a residue of simazin for at least 2 years. Corn can be grown normally during the period of sterility but most other crops will be seriously affected by the residue of simazin in the soil.

## LEAFY SPURGE

**L. A. Derscheid**

Leafy spurge is a deep-rooted perennial that emerges early in the spring like hoary cress. It spreads by underground parts and by seed. It is more difficult to eliminate than field bindweed, Canada thistle or perennial sowthistle. It has been eliminated by the use of intensive cultivation or soil sterilants. Competitive crops or hormone-type chemicals gave control of this weed, but were used together or were used in conjunction with intensive cultivation before they gave complete elimination.

**Intensive cultivation.** Proper cultivation eliminated a high percentage of leafy spurge. A field duckfoot cultivator equipped with wide (12 to 24 inches) overlapping sweeps was a satisfactory implement. When sweeps were kept sharp, overlapped three to four inches, were kept flat when in operation and were operated at a depth of four to five inches, every shoot was cut by each cultivation. Cultivation every two weeks prior to August 1 and every three weeks thereafter, eliminated over 95 percent of the spurge in one year. The first cultivation was performed shortly after the spurge emerged, and the last one was performed in October so that nine cultivations were performed. Cultivation at two-week intervals for the entire season was equally effective, but cultivation at three-week intervals was less satisfactory.

The use of intensive cultivation for part of the season with the production of a competitive crop and an application of 2,4-D was generally more practical than an entire season of cultivation. Income from the crop was obtained and the hazards of erosion, resulting from a full season of cultivation, were reduced. However, more time was required to secure 95 percent elimination.

**Selective herbicides.** Numerous forms and formulations of chlorinated aryl acids were tested. The phenoxyacetic acid compounds were superior to others. 2,4-D forms were equal to or superior to the corresponding form of 2,4,5-T, MCPA or 4-CPA. The ester form of 2,4-D was superior to the amine form in most cases. Of the ester forms, the butoxyethanol ester was one of the most effective formulations. An application of one-third pound per acre was sufficient to prevent seed production

and kill seedlings, but about one pound was needed to aid in elimination. 2,4-D did not give satisfactory elimination unless repeated treatments were made. Applications of one-third pound every two weeks has given 90 percent elimination in one year and three applications of three pounds each year has given 95 percent elimination in two years. It was most useful, however, in an elimination program when used in combination with cultivation and a competitive crop.

However, forty pounds per acre of 2,4-D has frequently given over 90 percent elimination of leafy spurge when applied during late fall. Applications were made to the soil and best results have been obtained when the soil temperature was below 50°F. Treatments after freeze-up have been effective.

**Non-selective herbicides.** TBA, amitrol, and silvex have been used to control leafy spurge with varying degrees of success. Forty pounds per acre of 2,3,6-TBA have consistently given 95-100 percent elimination. On occasion, 20 pounds have been equally effective, but have generally killed only about 75 percent of the spurge. In some cases mixtures of tetrachloro and trichloro isomers of TBA have been equal to 2,3,6-TBA, but in general two or three times as much was needed to give the same results.

Amitrol and silvex have been inconsistent. Sixteen to 20 pounds per acre of amitrol have frequently killed spurge in uncultivated areas, but have been ineffective on spurge that had been cultivated. Mowing in the bud stage before the application of amitrol has sometimes aided in the elimination. If the spurge was plowed 10 days after treatment, the use of 20 pounds of silvex has killed 85 to 95 percent of the spurge in most tests, and 10 pounds has been equally effective in some, but not in others. Without the plowing, rates up to 40 pounds per acre have been unsatisfactory.

**Combinations of cultivation, crops and chemicals.** Winter wheat and winter rye aided in the control of leafy spurge. When three cultivations were performed between harvest of one crop of winter rye and the seeding of the next crop, the weed was controlled but only half of it was eliminated with a three-year program. When the same program was followed except that the rye was sprayed with one-half pound of a 2,4-D ester per acre during the spring, the percentage of elimination was increased.

Spring sown small grains were satisfactory crops when one-half pound of 2,4-D ester was applied in the grain, and three cultivations were performed after harvest. Excellent control was obtained and a high percentage of elimination was obtained when such a practice was continued for three years. An application of one pound of 2,4-D ester in the stubble was less satisfactory than the three cultivations. An application of 2,4-D in the grain and a treatment of four pounds of 2,3,6-TBA in the stubble followed 10 days later with plowing gave 60 to 70 percent elimination of the spurge in one year. The residual effect of the TBA sometimes caused slight damage to small grain planted the next year, however. The use of eight pounds of amitrol in the stubble followed in three weeks by plowing was slightly less effective than the TBA.

When six or seven cultivations were performed prior to fall seeding of alfalfa and when a heavier than normal stand of alfalfa was obtained, much of the leafy spurge was eliminated in three years. However, when the density of stand was decreased by disease or winter killing, very little elimination was obtained.

A bromegrass stand sprayed twice a year with one pound of 2,4-D ester per acre gave excellent control and 80 to 90 percent elimination in three years. When seven cultivations were performed before the bromegrass was fall seeded and the crop was sprayed twice a year each of the next two years, 99 percent elimination was achieved. Two crops of bromegrass following the intensive cultivation produced as much hay as the three crops from plots that did not receive the cultivation. Top dressing of 120 pounds of ammonium nitrate applied in the spring did not change the competitive effect of bromegrass.

One year of sudangrass, buckwheat, or forage sorghum reduced the stand 50 percent when three cultivations were performed before the crop was close-drilled during late June and the area was fall plowed after harvest. The buckwheat produced seed and the other crops produced forage.

When four pounds per acre of 2,3,6-TBA were applied to spurge foliage during May and the area was plowed ten days later and planted to corn that was checked and cultivated three times, 80 to 90 percent of the spurge was eliminated. In one case out of five, the corn was injured. When eight pounds per acre of amitrol were used in the same manner, 50 to 60 percent of the spurge was killed. The use of silvex at rates of 10 to 20 pounds acid equivalent in the same manner gave 80 to 90 percent kill of the spurge, but the higher rate generally injured the corn. The use of several mixtures of amitrol and 2,4-D followed by cultivation gave a high percentage of elimination in a limited number of tests.

**Soil sterilants.** Numerous soil sterilant chemicals have been tested for the elimination of small patches. The results indicate that the following amounts of the various chemicals per square rod generally killed 95 to 99 percent of the weeds: (1) borax compounds—6 to 8 pounds of boron trioxide equivalent, (2) sodium chlorate—5 pounds, (3) borate-chlorate mixtures—7 to 8 pounds, (4) borate-2,4-D mixtures containing 5-8 parts boron trioxide to 1 part 2,4-D acid—3.5 to 4 pounds, (5) chlorate-borate-monuron mixtures containing 90% chlorate and sodium metaborates—4.5 to 7 pounds, (6) ammonium sulfamate—4 to 5 pounds and (7) erbon—½ to 1 pound. All of the chemicals were generally more effective when applied during the fall. The higher rate listed above was generally required for summer treatments. In a limited number of trials borate-MCPA mixtures containing 8-10 parts boron trioxide equivalent to 1 part MCPA acid gave 85 to 87 percent elimination at a rate of 3 to 5 pounds active ingredient. Similar mixtures containing monuron were equally effective. The substituted urea compounds (monuron, diuron and fenuron) were generally ineffective against this deep-rooted perennial.

The length of time that the residual effect of these chemicals prevents crop production varies with the soil texture and rainfall. On a loam soil in a 22-inch rainfall belt, the various chemicals, when applied at rates required to kill spurge, prevented the production of an oat crop for the following number of years: Borax compounds, 3 to 5; borate-chlorate mixtures, 3 to 5; sodium chlorate, 2 to 4; chlorate-borate-monuron mixtures, over 2; erbon, 2; borate-2,4-D mixtures, 1 to 2; and ammonium sulfamate, less than 1 year.

Some of these chemicals act faster than others. As a general rule, ammonium sulfamate gave the quickest top kill followed in order by erbon, borate-2,4- mixtures, sodium chlorate, borate-chlorate mixtures, borax compounds, and chlorate-borate-monuron mixtures. For summer treatments, it was necessary to use some other method of preventing seed production for all chemicals except ammonium sulfamate, erbon and borate-2,4-D mixtures.

**Grazing.** Sheep have been useful for eliminating leafy spurge. There were no harmful effects on the sheep. The degree of control was dependent on the intensity of grazing. Grazing was most effective when the sheep were turned into the area during early spring and allowed to graze closely. When sheep could not keep the area grazed closely, it was helpful to rotate cattle ahead of the sheep. The cattle kept the grass grazed and the sheep finished the grass and ate the spurge.

## RUSSIAN KNAPWEED

**L. A. Derscheid**

Russian knapweed is a deep-rooted perennial weed that emerges later in the spring than leafy spurge or hoary cress, but earlier than field bindweed, Canada

thistle or perennial sowthistle. It spreads slowly by underground parts and sometimes by seed, but frequently fails to produce seed. It is one of the most difficult weeds to eliminate. It has been eliminated by use of intensive cultivation or soil sterilants. Competitive crops or hormone-type chemicals have controlled this weed, but were used in conjunction with intensive cultivation before elimination was obtained. Several combinations of competitive crops, cultivation and 2,4-D application eliminated 90 percent of the knapweed, but the last 10 percent were very difficult to kill.

**Intensive cultivation.** Proper cultivation eliminated a high percentage of Russian knapweed. A field duckfoot cultivator equipped with wide (12 to 24 inches) overlapping sweeps was a satisfactory implement. When sweeps were kept sharp, overlapped three or four inches, were kept flat when in operation and were operated at a depth of four or five inches, every shoot was cut by each cultivation. Cultivation every two weeks prior to August 1 and every three weeks thereafter, eliminated over 95 percent of the knapweed in one year. The first cultivation was performed shortly after the weeds emerged and the last one was performed in October so that nine cultivations were performed. Cultivation at two-week intervals for the entire season was equally effective, but cultivation at three-week intervals was slightly less satisfactory.

The use of intensive cultivation for part of the season with the production of a competitive crop and an application of 2,4-D was generally more practical than an entire season of cultivation. Income from crop was obtained, and the hazards of erosion, resulting from a season of cultivation, were reduced. However, more time was required to secure 95 percent elimination.

**Selective herbicides.** Numerous forms and formulations of chlorinated aryl acids were tested. The phenoxacetic acid compounds were superior to the others. 2,4-D forms were equal to or superior to the corresponding forms of 2,4,5-T, MCPA, or 4-CPA. The ester form of 2,4-D was superior to the amine form. Of the ester forms, the butoxyethanol ester was one of the most effective formulations. An application of one-half pound per acre was sufficient to prevent seed production or kill seedlings, but three times this amount was needed to aid in elimination. 2,4-D did not give satisfactory elimination unless repeated treatments were made. It was most useful in an elimination program when used in combination with intensive cultivation and a competitive crop.

**Non-selective herbicides.** TBA, amitrol, silvex and several other chemicals have been used to control or eliminate knapweed with varying degrees of success. Forty pounds per acre of 2,3,6-TBA have consistently given 95 to 100 percent elimination. On occasion as little as 10 pounds has been equally effective, but in a majority of the tests, ten- and twenty-pound rates have not given complete elimination. Mixtures of tetrachloro- and trichloro- isomers of TBA have also been tested. In some cases, they have been equal to 2,3,6-TBA, but in general two or three times as much was needed to give similar results.

Amitrol has produced inconsistent results on knapweed. Applications of five or six pounds per acre have resulted in complete elimination in some instances, whereas, applications of 20 pounds have only stunted the growth in others.

Silvex was ineffective when applied at rates of 10, 15 and 20 pounds per acre.

**Combinations of cultivation, crops and chemicals.** Winter rye and winter wheat were effective in reducing the stand of Russian knapweed when augmented by cultivation and 2,4-D. Three crops of rye sprayed with one pound of 2,4-D ester in the grain and followed by three cultivations after harvest eliminated 70 percent of the knapweed. Substitution of a one and one-half pound application of 2,4-D ester for the three post-harvest cultivations increased the percentage kill by almost 10 percent. Fall-sown grains had no advantage over spring-seeded grain as far as elimination of knapweed was concerned. They did, however, furnish cover over winter and reduce the risk of erosion.

When six or seven cultivations were performed prior to fall seeding of alfalfa and the crop was harvested for hay each of the following two years, 60 to 70 percent of the knapweed was eliminated. Similar results were obtained when the alfalfa was grown in a mixture with bromegrass or crested wheatgrass. Less than half the knapweed was eliminated by three years of alfalfa seeded without prior intensive cultivation. Likewise, little more hay was obtained from three crops which did not have prior cultivation, than was obtained from two crops which were preceded by the six or seven cultivations.

Bromegrass or crested wheatgrass that was sprayed twice a year with one and one-half pounds acid equivalent of a 2,4-D ester per acre gave 70 to 75 percent elimination in three years. When seven cultivations were performed before either grass was fall seeded and the crop was sprayed twice a year each of the next two years, 90 percent elimination was achieved. Two crops of grass following the intensive cultivation produced as much hay as three crops produced when the cultivation was not utilized.

A combination of one and one-half pounds acid equivalent of a 2,4-D ester per acre applied during August, followed by three intensive cultivations the following spring before sudangrass was close-drilled during late June and was fall plowed after the crop was harvested for forage proved to be one of the most effective combinations tested. However, much less satisfactory results were obtained when the August application of 2,4-D was omitted.

When four pounds per acre of 2,3,6-TBA were applied to knapweed foliage during May and the area was plowed ten days later and planted to corn that was checked and cultivated three times, 80 to 90 percent of the knapweed was eliminated in two tests. In one test, the corn was injured.

Amitrol was ineffective in eliminating the knapweed, when applied before planting corn as outlined for TBA at the rate of eight pounds per acre. Silvex used in the same way at rates of ten and twenty pounds per acre was ineffective. Elsewhere amitrol has been inconsistent. Applications of five or six pounds per acre have resulted in complete elimination in some instances; whereas, in other areas, applications of twenty pounds have only stunted growth.

**Soil sterilants.** Numerous soil sterilant chemicals have been tested for the elimination of patches of Russian knapweed. The results indicate that the following amounts of the various chemicals per square rod generally killed 95 to 99 percent of the weeds: (1) sodium chlorate—5 pounds, (2) borax compounds—10 pounds boron trioxide equivalent, (3) borate-chlorate mixtures —8 pounds, (4) ammonium sulfamate—4 to 6 pounds, (5) borate—2,4-D mixtures containing 5-8 parts boron trioxide to 1 part 2,4-D acid—3.5 to 4 pounds, erbon—½ to 1 pound and chlorate-borate monuron mixtures containing 90% sodium chlorate and sodium metaborates—4.5 to 7 pounds. Consistent results were obtained from fall applications, but not from summer treatments. The boron compounds were more effective than other chemicals when applied to loam soils during the summer, but were less satisfactory when applied to clay soils either in summer or fall.

The substituted urea compounds (monuron, diuron and fenuron) have, in general, been ineffective in eliminating this deep-rooted perennial. However, 100 percent elimination was obtained on plots that were inundated for a month after being treated with one-third pound active ingredient of monuron per square rod.

An indication of the length of time that these chemicals keep the soil unproductive and an indication of the relative rapidity of herbicidal action are given in the summary for leafy spurge.

**Grazing.** In one or two instances, sheep have been used to eliminate this weed. Two or three years of intensive overgrazing were required to eliminate the weed.



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## FIELD BINDWEED

**W. M. Phillips**

Prior to 1945 much of the field bindweed control research was concerned with the use of intensive cultivation, and cultivation combined with competitive crops for control of large areas of the weed. Chemicals such as sodium chlorate and various boron compounds were used as soil sterilizing herbicides for control of relatively small areas.

Beginning in 1945 extensive experiments were conducted to determine the effect of 2,4-D on field bindweed. In part of the North Central region, particularly the more humid sections, 2,4-D proved to be an effective bindweed control herbicide. However, throughout much of the Great Plains area, apparent initial successes with 2,4-D were followed by considerable bindweed regrowth. This led to experiments using 2,4-D in conjunction with intensive cultivation and competitive crops. A combination of these methods is now being recommended throughout much of the Great Plains.

Under many conditions small patches of field bindweed can best be controlled with soil sterilizing herbicides. Although these chemicals are expensive on a cost per acre basis, their use on small areas often prevents spread of the weed over entire fields. Most sterilants have a further disadvantage of reducing land productivity for two or more years. Numerous soil sterilizing experiments have been conducted since 1950. Among the chemicals used, in addition to sodium chlorate and borates, were monuron and other substituted urea compounds, mixtures of sodium chlorate and borates, and various combinations of sodium chlorate, borates, substituted ureas, and 2,4-D. More recently, much research emphasis has been placed on the chloro-substituted benzoic acids.

**Control with intensive cultivation.** Proper cultivation eliminated a high percentage of field bindweed. Best results were obtained when cultivations were performed 8 to 10 days after each bindweed emergence. The total interval between cultivations varied, but usually was 15 to 20 days. Repeated cultivations for one year sometimes eliminated the weed, but cultivation during the second year was generally necessary. The duckfoot cultivator was the best implement for performing these cultivations. In many cases cultivation was most practical when used in combination with competitive crops and 2,4-D.

**Control with selective chemicals.** Applications of 0.75 to 1 lb/A of 2,4-D were necessary for the control of bindweed growing on land that was not being cropped at the time of treatment. The lower rate was sufficient for more humid areas. When the weed was growing in tolerant or semi-tolerant crops, 0.50 lb. of 2,4-D per acre was frequently sufficient to give good control, but stand reduction was often less than that obtained with higher rates. Best control was obtained by applying the 2,4-D to bindweed which was growing vigorously. Such growth conditions generally occur at the bud to early bloom stage of growth, or if soil moisture is available, in the fall. Several retreatments with 2,4-D or the use of competitive crops and cultivation were usually required to give complete elimination.

The use of 0.50 lb. of 2,4-D per acre shortly after bindweed seedlings emerged prevented reinfestation after the original stand had been eradicated. Other selective chemicals tested were generally less satisfactory than 2,4-D. Heavy rates of application, 40 or more lb/A, of 2,4-D, 2,4,5-T and silvex have been used experimentally. Results following these treatments were inconsistent, but silvex appeared most promising.

**Control with cultivation, competitive crops and 2,4-D.** Competitive crops such as winter wheat or rye, drilled forage sorghum, sudangrass, perennial forage crops, and soybeans, may be used in conjunction with intensive cultivation. The use of a particular crop is necessarily limited to its area of adaptation. Such a system has advantages over intensive cultivation alone in that some return from the land is realized, and the soil has some protection from wind and water erosion.

One season of intensive cultivation followed by one crop of winter wheat or winter rye has eliminated a high percentage of field bindweed. Complete elimination has been achieved when the fallow season was followed with two or three crops and the stubble cultivated at about 3-week intervals each year between harvest and seeding of the crop. The use of spring-sown grains gave nearly equally good kills, but had the disadvantage of leaving the soil bare over winter.

A high percentage of bindweed has been eliminated in three years by spraying with 2,4-D in a grain crop and cultivating three or four times after harvest each year. Less satisfactory results were obtained when corn or sorghum was raised any of the three years.

One short season of intensive cultivation followed by a fall seeding of alfalfa alone or in a mixture with a vigorous cool season grass that was cut for hay each year has been effective. Annual applications of ½ to 1 lb/A 2,4-D to bindweed-infested native or seeded grass stands eliminated most of the bindweed in three years.

Two or three spring cultivations followed by a close-drilled crop of forage sorghum, sudangrass or soybeans gave 85 to 90 percent elimination when continued for three years. The crop was harvested for forage and the area was cultivated once or twice after harvest each year.

In a year of fallow, 2,4-D has been used to successfully substitute for some of the cultivations. The bindweed may be sprayed at bud stage in the spring, or the spraying may be delayed until after two or three months of intensive cultivation. In either case intensive cultivation should be resumed as soon as bindweed regrowth appears.

**Control with soil sterilizing chemicals.** Small patches of bindweed have been eradicated by use of soil sterilants. The following chemicals have given nearly complete elimination: sodium chlorate at 4 to 6 lb/sq rd (640 to 960 lb/A), borate-chlorate mixtures at 8 to 10 lb/sq rd (1280 to 1600 lb/A) borax compounds at 10 to 11 lb/sq rd of boron trioxide equivalent (1600 to 1760 lb/A), and, when adequate moisture was available, monuron or fenuron at 40 to 80 lb/A. In some areas the 80 lb rate is usually necessary. Because of long residual effect in the soil, monuron and other highly persistent chemicals should be used on non-crop land only. Mixtures of monuron and borates, and monuron, sodium chlorate, and borates were also effective when used as soil sterilants.

In recent experiments, several chlorinated benzoic acid compounds were effective. A formulation which contained approximately 50% 2,3,6-trichlorobenzoic acid and other active isomers often gave 80 to 100 percent elimination when applied at rates of 15 to 20 pounds acid equivalent per acre. Occasionally lower rates were effective and in several cases rates as high as 30 pounds were necessary. A mixture primarily of dichloro-, trichloro- and tetrachloro- benzoic acids has been equally effective when applied at rates of 30 to 50 pounds per acre. The residual effect of the chemicals generally prevents or reduces crop production for two or more years.

One preliminary report indicated that 2,3,6-trichlorophenylacetic acid may be effective for bindweed control, but additional information is needed.

The killing action of many soil sterilants is slow. Retreatments to kill surviving plants should be made one to two years after the original application.

**Control with grazing.** Sheep have been useful in eliminating bindweed. A high percentage has been eliminated in one year by grazing a spring pasture of winter rye or winter wheat until heading time. The sheep were removed and sudangrass was seeded. When this crop was six inches tall, the sheep were returned and allowed to graze until it was time to seed a second crop of rye or wheat. Complete elimination was obtained in two years.



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## HOARY CRESSES

**P. F. Sand**

The effectiveness of 2,4-D on hoary cress has been evaluated since 1946. Generally, rates of 2,4-D at 2 to 4 lb/A were more effective than lighter rates and the esters more effective than the salt formulations. Applications of 2,4-D at the fall rosette and bud stage in the spring were the most effective in reducing the stand of this weed. One-half to one lb/A of 2,4-D controlled hoary cresses in growing crops when applied at the bud stage. Retreatment of the fall rosettes with 2,4-D at 2 lb/A gave substantial stand reduction. Such a combination of treatments gave almost complete elimination after two to three seasons. If hoary cress was growing in sod, 2 lb/A of 2,4-D applied at the bud stage in the spring and retreated in the fall rosette gave nearly complete eradication if repeated for three seasons. Hoary cress was more easily eliminated with 2,4-D from sod than from cultivated land. This may have been due to the unevenness of emergence in the cultivated land.

One investigator reported a ninety-nine percent reduction in stand of hoary cress by application of 6 lb/A of amitrol followed by one or two cultivations and retreatment at 3 lb/A plus a late fall cultivation.

Soil sterilants can be used to eliminate small patches of hoary cresses. Sodium chlorate at 4 to 6 lb/sq rd (640 to 960 lb/A) or boron chlorate mixtures at 8 to 10 pounds per square rod (1,280 to 1,600 lb/A) gave satisfactory kills. Monuron can be used on non-crop land when there is abundant soil moisture at the rate of 40 lb/A. A fall or early spring application of 2,4-D at 10 lb/A may also be used. Soil sterilant chemicals should be applied 6 to 8 feet beyond the existing infestation. Spot treatments following applications of soil sterilants should be used to kill remaining plants. Seedlings may be controlled with 2,4-D foliage sprays, by cultivation, or by seeding to a close-growing grass crop and using supplemental 2,4-D treatments.

## CANADA THISTLE AND PERENNIAL SOWTHISTLE

**E. P. Sylwester**

Both Canada thistle and perennial sowthistle are deep-rooted perennials that spread by underground roots and by seed. Each seed (achene) possesses a large pappus which serves as a parachute and allows wind currents to carry the seed great distances. Both species emerge later than leafy spurge, hoary cress, Russian knapweed or field bindweed and are less difficult to control or eliminate. Prevention of seed production is paramount if these weeds are to be kept from spreading to new areas. Intensive cultivation, soil sterilants, competitive crops, selective chemicals and several combinations of cultivation, crops and chemicals have given control or elimination.

**Intensive cultivation.** One complete season of proper cultivation (summer fallowing) gave almost complete elimination of both thistle species. This method can be used where erosion is not a problem. Fallowing must be from spring to freeze-up, or from immediately after small grain harvest until freeze-up of the following year. A duckfoot field cultivator and one-way disk are equally satisfactory implements when operated at a depth of four to five inches. If sweeps on the duckfoot cultivator are kept sharp, overlapped three or four inches and kept flat in operation, every shoot is cut by each cultivation. Likewise, sharp disks on the one-way disk cut each shoot with every operation. When operations are performed at three-week intervals, over 95 percent of the weeds are eliminated in one year. Plowing in the spring, after growth has started, is usually the first operation of the fallowing program. Summer fallowing is continuous from then until the last of October, requiring 5-7 operations. In some of the less humid areas cultivation every four weeks has been equally effective. A tandem disk harrow was unsatisfactory even when used at two-week intervals. Over 90 percent of the thistles are killed in so many different ways, involving crop production, that the use of an entire season of intensive cultivation (summer fallowing) is seldom practical. Intensive cultivation in the spring followed by a good summer smother crop such as close drilled soybeans, sorghums, millet, or sudangrass, and summer fallowing as soon as the crop is removed gives good control in 2 to 3 years without loss of crops. Also, summer fallowing operations if started in the spring, may be discontinued after mid-July and the thistles treated with 1 pound of 2,4-D per acre. Start tillage again when regrowth appears and continue to freeze-up. Mowing at bud stage does not reduce stand of thistles appreciably but does reduce plant reserves in preparation for other treatments.

**Selective chemicals.** Numerous forms and formulations of chlorinated aryl acids were tested. The phenoxypropionic acid compounds were not satisfactory. 2,4-DB was superior to other phenoxybutyric acid compounds. One to two pounds acid equivalent per acre prevented seed production of Canada thistles and weakened the plants. This has been an aid in establishing alfalfa stands. The phenoxyacetic acid compounds were most effective in an elimination program. 2,4-D was generally more effective than 2,4,5-T, MCPA or 4-CPA for the elimination of sow-thistle, however, MCPA was often equal to and sometimes superior to 2,4-D on Canada thistle. An ester formulation of 2,4-D was generally superior to an amine formulation for elimination of sow-thistle, but there was little difference between the two on Canada thistle. Rates of one-third to one-half pound acid equivalent per acre prevented seed production, eliminated some plants and weakened others so that subsequent treatments killed them. 2,4-D and MCPA were often found as effective when applied to the rosette stage (either spring or fall) than when applied to the bud stage of growth. Two treatments in one year with 2,4-D or MCPA (spring and fall rosettes) frequently killed a high percentage of the thistles. As a general rule, however, thistles that were not killed by two treatments in the first year, were more resistant to the chemical and could not easily be killed by spraying. Some other treatments, such as cultivation, were required to eliminate them.

**Non-selective chemicals.** Amitrol has given complete elimination of Canada thistle, in many cases, when applied at rates of four to six pounds active ingredient per acre in 30-50 gallons of water per acre when the thistles were in pre-bud stage. Such a treatment has generally given over 90 percent elimination. Similar applications made to thistles that were six to eight inches tall has given good top kill, but generally very little root kill. Excellent results have also been obtained by treating second growth thistles, 8 inches high to bud stage, preceded by June mowing or plowing. This method is particularly valuable in meadows but amitrol is not a selective spray. Sowthistle generally is less susceptible to amitrol than Canada thistle.

**Combinations of cultivation, crops and chemicals.** Numerous crops have been utilized to control and eliminate Canada and perennial sowthistle. In some cases no chemical or cultivation was required. When other crops were used, however, spraying and/or cultivation were required to give any appreciable amount of elimination.

One season of intensive cultivation followed by winter wheat or winter rye has eliminated a high percentage of both species in areas where winter wheat or winter rye are adapted. However, complete elimination was achieved with two or three crops when the stubble was cultivated each year at three-week intervals after harvest and before the succeeding crop was sown. The method is repeated the following year if thistles remain and continued until they are eliminated.

A high percentage of thistles has been eliminated

the year that spring sown grain was raised, when one-half to three-fourths pound of 2,4-D acid equivalent was applied per acre in the grain and follow-up fall operations were performed. The percent of kill was dependent on the type of fall operation utilized. Three post-harvest cultivations gave 85 percent elimination in one year and 100 percent in two years. Plowing after harvest and spraying the thistles with three-fourths to one pound 2,4-D or MCPA acid equivalent after they emerged on the plowing killed 85 percent of the weeds in one year, and 98 percent in two years. Post-harvest spraying resulted in a 50 percent kill in one year and 100 percent in three years. Late fall plowing (late October) gave 70 percent elimination in three years when used as the only fall treatment, but did not improve the kill when any of above fall treatments were used. Top growth can usually be killed and seed formation prevented in grain crops by maximum rates of 2-4-D for the crop concerned. MCPA may also be used on Canada thistle but is less effective on perennial sowthistle.

Very few thistles were eliminated in corn that was sprayed once with 2,4-D or MCPA. However, two applications of one-half to three-fourths pound per acre (applied at time of second cultivation and with drop nozzles after tasseling) gave 40 percent elimination in one year.

A good crop of alfalfa or alfalfa-bromegrass mixture, which was cut regularly for hay each year, gave almost complete elimination of both species in three years. Although the sowthistle became thicker the first year, 75 to 85 percent elimination was achieved by the end of the second year. A good crop of bromegrass gave very similar results except that only 95 percent elimination was obtained in three years. When the bromegrass was sprayed with three-fourths pound of 2,4-D or MCPA acid per acre twice a year, 95 percent elimination was obtained in two years, and it was not improved by repeating the treatment a third year. Infested areas may also be seeded to a suitable and strongly competitive grass and treated with 2,4-D to weaken the thistles and enable the grass to take over. Annual treatment with 2,4-D, one pound per acre during the life of the grass stand will aid in the reduction of thistle stands. This method is excellent for roadsides, ditches, fence rows, slough edges, waste areas, pastures etc. 2,4-D is the best selective spray to use in grassy pastures. Usually at least two applications of 2,4-D each over a period of 2-3 years are necessary to eradicate Canada and perennial sowthistle. The first application each year should be made at the early bud stage and one or more treatments should be made later in the summer or early fall. Rates over 1 pound per acre tend to be less effective than is ½ to 1 pound per acre rate. Canada thistle and perennial sowthistle are more effectively treated with 2,4-D and MCPA than with 2,4,5-T. Perennial sowthistle is somewhat more readily controlled than Canada thistle, especially if ester formulations are used.

On non-crop land repeat dosages of the ester form of 2,4-D at the 1 pound per acre rate will usually control, if not completely eradicate Canada thistle and perennial sowthistle. Best results occur when thistles are in bud to first bloom stage.

When five intensive cultivations were performed prior to an August seeding of alfalfa, bromegrass or alfalfa-bromegrass mixture, 88 percent elimination of both species was obtained in one year and over 95 percent in two years. When the bromegrass was sprayed with three-fourths pound of 2,4-D or MCPA acid per acre twice during the second year, the percent kill was increased to 100.

**Soil sterilants.** Numerous soil sterilants have been tested for the elimination of small patches of thistles. The results indicate that the following amounts of the various chemicals per square rod generally killed 95 to 99 percent of the weeds: sodium chlorate—4 to 5 pounds, Atlacide—6 to 8 pounds, Polybor-chlorate—10 to 12 pounds, Chlorax—10 to 12 pounds, Concentrated Borascu—12 to 15 pounds, Polybor—12 to 15 pounds, Ammate X—5 to 6 pounds, DB Granular—5 pounds, Chlorea—5 pounds, Baron—½ to 1 pound. Fall applications were generally more dependable than summer treatments, but the reverse was sometimes true. Ureabor, monuron, diuron and fenuron were inconsistent, but 7½ pounds per sq. rod of Ureabor or ¼ pound active ingredient of the urea compounds, sometimes gave a high percentage of elimination. Use of soil sterilants is limited to rather small areas and patch treatment should be made at least 6 feet beyond where last plants are visible. Retreatments are usually necessary and the soil is unproductive for 1-3 years or more. Sodium chlorate is generally most effective if applied as a soil sterilant in the fall of the year, when leaching and decomposition losses are minimized.

**Control of seed production.** These weeds are spread over large areas because the seeds are easily carried by wind, water, birds, and animals, as well as man. Therefore, the control of seed production is very important. Research results show that Canada thistle plants have flowers with degenerate female organs and act as male flowers, while other plants have heads that function as females. Canada thistles are therefore cross pollinated before seed is produced. Perennial sowthistle, on the other hand, produce complete flowers, but research results indicate that this species is also largely cross-pollinated. In greenhouse tests, it appeared that insects did most of the pollination and that wind currents did very little for either species.

A high percentage of the seeds of both species were viable eight to ten days after the heads opened. Mowing prevented the production of viable seeds if done during the first week after the plants bloomed. Likewise spraying with one-third pound of 2,4-D acid per acre any time between six days pre-bloom and four days past bloom prevented the production of viable seed. The seed of neither species germinated readily when planted over one-half inch deep in soil. They needed light and plenty of oxygen before they would germinate.

**Current research.** In 1958 studies of these thistles (See Research Report), amitrol continued to give good results and trichlorobenzoic acid (Tryben) and other polychlorobenzoic acid formulations, 2-(MCPP), 1:1'-ethylene-2:2'-bipyridinium dibromide (FB-2), 3-(3,4-dichlorophenyl)-1,1-diethylurea, simazin, and silvex, in addition to those already mentioned, gave satisfactory control, at least under some conditions.

## BUR RAGWEED

**P. F. Sand**

Bur ragweed is a deep-rooted perennial weed native to a few of the midwestern states. It reproduces by seed and roots, but the seed is seldom found in crop seed because it matures late in the fall.

**Foliage treatments.** Results of treating bur ragweed with 2,4-D, 2,4,5-T, and MCP have been erratic. Generally, the ester formulations of these chemicals gave greater reduction in stands than the amine formulations and 2,4-D gave more effective control than MCP or 2,4,5-T. The greatest reduction in stand was obtained from a June application. However, treatments in late May in Kansas were effective. Treatment in July gave results inferior to June treatments, and August and September treatments gave no reduction in stand.

Reduction in stands of 85 percent were consistently obtained with a June treatment of 2 lb/A of 2,4-D ester in 20 gpa of diesel oil. Oil-water emulsions of 2 and 4 lb/A of 2,4-D amine were about equally effective. When water was used as a carrier, both 2,4-D ester and amine at 2 lb/A applied in June gave 80 to 95 per cent reduction in stand when moisture conditions were favorable. However, under unfavorable conditions 60 per cent control was obtained from ester formulations and no reduction in stand from the amine formulation.

**Soil treatments.** Sodium chlorate at 4 to 6 lb/sq rd (640 to 960 lb/A), soluble boron compounds at 8 to 10 lb/sq rd (1,280 to 1,600 lb/A), the boron-chlorate mix-



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tures at 8 to 10 lb/sq rd (1,280 to 1,600 lb/A), or granular boron compounds at 12 to 15 lb/sq rd (1,920 to 2,400 lb/A) can be used to eliminate small patches. Soil sterilant chemicals should be applied 6 to 8 feet beyond the existing infestation. The year following application of soil sterilants a spot treatment should be made to kill remaining plants.

Other chemicals that gave excellent control of bur ragweed two years after application were Chlorea at 5 to 7 lb/sq rd (800 to 1,120 lb/A); erbon at 160 lb/A; 2,3,6-TBA at 20, 40, and 60 lb/A; MCP potassium salt at 40 lb/A; MCP lithium salt at 40 lb/A; and polychlorobenzoic acid at 40 lb/A. Results with diuron on bur ragweed were not consistent. One investigator reported excellent control at 80 and 160 lb/A while another reported some reduction in stand and stunting of remaining plants at 40, 80, and 120 lb/A.

In 1958 chemicals that gave excellent control two years after fall treatment were sodium chlorate at 5 to 7 lb/sq rd; Chlorea at 5 and 7 lb/sq rd; erbon at 160 lb/A; 2,3,6-TBA at 40 and 60 lb/A; diuron at 80 and 160 lb/A; MCP potassium salt at 40 lb/A; MCP lithium salt at 40 lb/A; and PBA (80% TBA) at 40 lb/A. In a separate test at a different location 2,3,6-TBA at 20, 40 and 60 lb/A was the only hormone-type herbicide that gave satisfactory control two years after treatment.

## TOADFLAX

**H. A. Friesen**

Toadflax occurs over much of the Conference area but has become troublesome on agricultural land only in Western Canada and this within the past decade. Therefore, at the outset, much work was devoted to assessing the merits of known cultural and chemical measures for the control of this weed. Cultural methods appear to offer the only economical and practical means of controlling field scale infestations. Since the early work showed that at least three consecutive years of intensive summer fallowing were required to eradicate toadflax, research has centered on determining the place and frequency of the summer fallow in the rotation that would give sufficient control to permit satisfactory production of cereal crops. In conjunction with the rotation study experiments were initiated to determine: (a) the most effective timing and frequency of the tillage operations; (b) the best choice of implements, and (c) the use of chemicals as substitutes for part of the tillage. Seeding down to a strongly competing grass followed by spraying with 2,4-D has shown promise, particularly if seeding down was preceded by a season of intensive tillage. The competitive ability of various species of grasses is under study.

Soil sterilant compounds containing sodium chlorate will eliminate toadflax but their use is economically feasible only on very limited areas. A wide variety of herbicides are under test in order to find one which will be equally effective yet have a shorter residual effect, be less costly and less hazardous to handle than sodium chlorate.

Studies on growth characteristics, rate and mode of spread, seed germination and seedling establishment have been carried out.

**Cultural control.** On arable land a system of alternate fallow and cropping to a cereal grain will reduce toadflax stands by 95 per cent or more in one rotation cycle or to the extent where it does not interfere with successful grain production. Three complete cycles of this rotation have resulted in almost complete elimination (over 99 per cent) of the toadflax stand. The summer fallow must be cultivated intensively and preferably preceded by fall tillage. Regrowth between tillage operations should not be permitted to appear above ground for more than 5 to 8 days. Where wind erosion is a serious factor the land should be worked in alternate strips of crop and fallow. 2,4-D at 2 to 4 lb/A can be used to reduce the number of tillage operations required. Recent studies showed that amitrol at 8 lb/A; Concentrated Borascu and BDM* at 1-2 lb/100 sq ft (435-870 lb/A) used in this way were more effective than 2,4-D but the latter two compounds caused severe injury to the succeeding grain crop.

Present studies showed that two crops of grain may be taken after each year of intensive summer fallow without undue increase in the toadflax stand provided that thorough post-harvest and spring tillage is carried out prior to seeding the second crop after fallow. Early maturing barley, well fertilized, is the best choice for the second crop.

Seeding down to grass following a season of intensive tillage and repeated spraying of the sod with an ester of 2,4-D at not less than 2 lb/A have greatly reduced the stand and vigor of this weed. Four to five years will be required to result in elimination by this method. Brome grass was found to be a slightly stronger competitor than creeping red fescue.

**Chemical control.** Soil sterilants can be economically used to eradicate only small infestations or patches. Monuron at 1½ to 3 oz/100 sq ft (40-80 lb/A), sodium chlorate at 2 to 3 lb/100 sq ft (870-1305 lb/A), BDM or Concentrated Borascu at 2 to 3 lb/100 sq ft (870-1305 lb/A), or chlorate-borate compounds at 4 lb/100 sq ft (1740 lb/A) have resulted in satisfactory control. All rates given are in pounds of product. While residual effect tends to be longer with monuron, each of the other treatments may adversely effect crop growth for 3 or more years. Concentrated Borascu and BDM have shown a high degree of selectivity when used at lighter rates on toadflax growing in cultivated or native sod. Repeated treatments with an ester of 2,4-D at upwards of 20 lb/A applied in the fall has given fair to good control. Amitrol has not given consistent results. Fall application of compounds containing borates and/or chlorates has been more effective than similar treatments applied in the spring.

* Borate ($B_2O_3$) 43.2%, 7% 2,4-D.

## OTHER PERENNIAL WEEDS

**H. A. Friesen**

**Field horsetail.** Good top growth control in cereal grains will result from spraying with an ester of MCPA at 4 to 6 oz/A when horsetail is fully emerged. The cereal crop will usually be in the early shot blade stage at this time. Repeating this treatment over a period of 2 to 3 years will reduce the stand of horsetail by upwards of 75 percent. 2,4-D may be used in place of MCPA but is less effective in reducing the stand of the weed and is more likely to result in crop injury. Selective control in grassland has been obtained with BDM at 1200 lb/A. Amitrol at 5 lb/A has given control in one trial.

**Wild garlic.** 2,4-D at 3 lb/A applied before the bulblets appear in the spring will give good control of top growth. However, dormant bulbs in the soil will require that follow-up treatments be made. The minimum follow-up treatments would be in the fall and in the following spring. If eradication is desired the treatments should be continued for another fall and spring.

**Poverty weed.** Top growth control only has resulted from treatment with a 2,4-D ester at rates up to 25 lb/A. Monuron at 20 lb/A and up has given satisfactory control. Seeding infested land down to crested wheatgrass and alfalfa will result in a marked suppression of this weed.

**Bladder campion.** BDM and Polybor-chlorate at 900 lb/A and monuron at 40 lb/A have prevented re-growth over a period of 3 years. One season of intensive tillage will reduce the stand of this weed sufficiently to permit satisfactory production of cereal crops in the following years. Seeding down to a strongly competing grass fol-

lowed by repeated spraying of the sod with 2,4-D at 2 lb/A will give a good measure of control.

**Blueweed.** One or two annual applications of 1 to 2 lb/A of an ester of 2,4-D during fallow periods in a fallow-wheat-fallow rotation can be used to eradicate blueweed on wheat farms. Monthly sweep tillage during such fallow periods also can be used for this purpose. Suitable rates of soil sterilants for small patches of blueweed in lb/sq rd were: BDM (granular), 4; sodium chlorate, 5; Concentrated Borascu, 12; fenuron, ¼; polychlorobenzoic acid, ⅛; and Baron, 2.

**Horse nettle.** An ester of 2,4,5-T at 3 lb/A will give near complete control of the top growth without injury to corn.

**Tanweed.** Polybor-chlorate and sodium chlorate at 8 lb/sq rd and Concentrated Borascu at 12 lb/sq rd resulted in 97-100 per cent elimination. Only the top growth of this weed was killed by 2,4-D at rates up to 40 lb/A.

**Absinthe.** Concentrated Borascu at 535 lb/A and BDM at 1000 lb/A of total product will eliminate this weed on cultivated land or in sod. Little or no injury to the grass will result from the use of these herbicides at the above rates. Amitrol, TBA and the amine of 2,4-D at 4 lb/A and the ester of 2,4,5-T at 14 lb/A applied in May and again in August will eliminate absinthe. Where the infestation occurs in seeded pastures somewhat lower rates could be used.

**Orange hawkweed.** This weed is best controlled by maintaining pastures at high level of fertility. Top growth of this weed and tansy may be controlled by applying an ester of 2,4-D at 3 lb/A during the bud stage and retreating in September.

**Buttercup.** This weed can best be controlled by treating it in the flowering stage with an amine of MCPA at 2 lb/A.

**Climbing milkweed.** 2,3,6-TBA at 20 lb/A, polychlorobenzoic amine at 40 lb/A, erbon at 80 lb/A, and amitrol at 8 lb/A followed by plowing gave excellent control in a trial conducted over a 2-year period.

**Yellow nutgrass.** In one trial EPTC incorporated in the top 2 inches of a peat soil in the spring inhibited germination of 90 percent of the tubers (tubers were not killed). In the same trial amitrol at 6 lb/A, dalapon at 15 lb/A and 2,4-D at 30 lb/A resulted in top growth control with subsequent regrowth.

## CONTROL OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS

**E. A. Helgeson**

**Broad-leaved weeds.** Early work on most of our broad-leaved weeds included studies on rates of chemical formulations and time of application as well as susceptibility at various stages. Resistant and susceptible reactions to 2,4-D were widely studied for a wide range of common weeds. Somewhat later MCP came in followed by a testing period for a large number of phenoxy, butyric, carbamate and other ring compounds for selective weed control and other compounds such as monuron, TBA, etc., for non-selective control.

At first post-emergence applications were stressed but more recently pre-planting and pre-emergence applications have received wide study. In general the post-emergence spray applications have been most satisfactory. Soil applications before crop emergence have tended to be unreliable due to soil and moisture factors.

Where no crop is involved there are a number of relatively new chemicals which appear promising. Recent tests of many of these indicate that they may also be valuable in selective control. Of the hundreds of chemicals or formulations tested the past 13 years or so only 2,4-D and MCP have been recommended for widespread use.

Some of the more recently introduced chemicals under test the past several years have included the following. Neburon at rates around 4 lb/A, controlled buckwheat in a crop as did the other substituted ureas, although the more soluble forms caused crop damage.

TBA, 2,4-DB and amitrol are new top killers having a wide range of toxicity, whereas TBA, simazin and the substituted ureas are active through the soil. These are somewhat selective if applied in proper amounts.

Delayed seeding following late spring cultivation is a recomended cultural control.

In addition to chemical and cultural control one should not overlook the excellent work on seed dormancy and germination that began about 5 years ago.

**Grasses.** The progress of chemical control of these weeds does not present the varied picture we find for broad-leaved weeds. The first practical selective grass killer (TCA) did not come into the picture until about 8 years ago. Prior to that salt, chlorate, borates, etc., were non-selective controls.

TCA and dalapon have proven to be excellent selective chemicals for use on foxtail and similar weedy grasses especially since they may be used in the flax and sugar beet crops. Also within the past year we have recommended CDAA for grass control (except wild oats) in corn and soybeans.

At present the wild oat is our most serious annual grass weed. While we can control it with dalapon at economical rates (4-6 lb/A) we still have the dormant seed problem with us. A large amount of work is being done on dormancy especially in our Prairie States and it is hoped that solutions to this problem will eventually be found. Gibberellic acid has been found to break this dormancy and several chemicals such as maleic hydrazide, dalapon and tetrachlorobenzene will induce this state or actually inactivate the seeds. As yet no practical method of application is available here.

On large infestations delayed seeding of a crop after repeated spring cultivations is the most practical control. Crop rotation is also a useful control measure.

## WEED CONTROL IN FIELD CROPS

## SPRING-SOWN GRAIN

**George Friesen**

Spring-sown grain crops are grown on approximately 90,000,000* acres annually in the area included in the North Central Weed Control Conference (14 north central states and 3 prairie provinces). This acreage is made up of approximately 34,500,000 acres of hard red spring wheat; 2,900,000 acres of durum wheat; 38,800,000 acres of oats; 13,500,000 acres of barley; 400,000 acres of spring rye and a limited acreage of mixed feed grain.

Weed control research in spring-sown grain, prior to the advent of 2,4-D was primarily directed to developing a program of timely and efficient cultural practices. Pre-seeding tillage, post-seeding harrowing, fall cultivations, and proper summer fallow practices, as well as sacrificing polluted crops, were generally recommended weed control measures.

Early experiments with 2,4-D were directed at determining resistant and susceptible stages of crop growth. In addition, numerous related studies were conducted, including differential response of crop varieties to 2,4-D, the effects of various 2,4-D formulations and rates of application on crop yield, morphological deformities, and grain quality. This was followed by research on crop losses caused by weed competition and studies on timeliness of spraying so as to reduce weed competition to a minimum.

It was found that the growth of spring-sown grain could be divided into four developmental periods; each



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responding in a different way to 2,4-D. These periods are described as follows: (1) A highly susceptible seedling period extending from emergence to the 5-leaf expanded stage when reaction to 2,4-D is expressed in leaf and spike deformities. In some experiments this period was found to be somewhat shorter. (2) A relatively tolerant period between the 5-leaf and early boot stage. (3) A second susceptible period extending from the boot stage to the fully headed stage, when 2,4-D causes a high degree of sterility. (4) A relatively resistant period begining when the grain is in the milk stage and continuing to full maturity. The onset and termination of these stages varied with crop varieties and/or growing conditions. It is currently recommended that wheat and barley should not be treated with 2,4-D until expansion of the fifth leaf or until the plants are approximately six inches in height. Treatment can then be safely made until the early boot stage as well as from the soft-dough stage until maturity. These development periods are not as well defined in oats as they are in wheat and barley.

Oats were found to be more susceptible to 2,4-D than wheat or barley and considerable damage was frequently reported when 2,4-D was used on oats. Visible manifestations of damage reported were any one of a combination of, the following: basal weakness, a tendency to "onion-leaf", a reduction in plant height, sterility, and decreased yield. The most vulnerable period corresponds to the second stage in wheat and barley and in general the ester formulations of 2,4-D proved most detrimental to the crop. Therefore, if 2,4-D is used on oats, it is advisable to use an amine formulation during the periods from emergence to the 2-leaf stage or between the 6-leaf and flag-leaf stages.

Little conclusive evidence has been submitted for wheat varieties differing in response to 2,4-D, but varietal differences have been noted in barley and oats. These varietal differences, however, seemed to vary with environmental conditions and it has not appeared practical to refine general recommendations to cover differences in varieties.

Little, if any, adverse effect on protein content and other quality characteristics of spring-sown grain, as a direct result of 2,4-D treatment, has been reported. In general, where spraying was done under weedy conditions, the tendency has been to increase the quality of harvested grain.

Following the introduction of 2,4-D a chemically related herbicide, MCPA, was included in some of the experimental trials. At herbicidal rates, MCPA proved safe to use on wheat, barley and oats at all the above mentioned growth stages. This allowed for a longer "safe period" in which to spray these crops and therefore MCPA can be applied as soon as weed conditions warrant.

Soon after the introductions of 2,4-D and MCPA it was found that not all broad-leaved weeds were killed by these herbicides. In many instances this has resulted in changes in the weed complex of grain fields with 2,4-D-resistant weeds increasing in seriousness. In recent years, research workers have placed increased emphasis on screening herbicides for the control of harder to kill weeds. A variety of compounds have been tested; some of which have been more or less effective in controlling the hard-to-kill weeds. A few examples will be cited. Neburon has been tested at several locations as a control for tartary buckwheat in wheat and barley. At dosages required to control the weed, wheat and barley have been resistant. Other substituted ureas, monuron and diuron, have been widely tested. Excellent weed control has been obtained under moist conditions, but damage to cereal crops was frequently noted. The butyrics (2,4-DB and MCPB) have been widely tested, but in general seem to offer little, if any, advantage over 2,4-D except where the grain has been underseeded with a legume. Various benzoic acid formulations show promise for certain hard-to-kill weeds, but seem to be quite harsh on all grain crops. More recently, simazin has shown considerable promise for certain hard-to-kill weeds in wheat and barley, but results to date are inconclusive.

Since 1952 increasing attention has been given to the chemical control of wild oats, and a large number of chemicals have been tested. Initial experiments were conducted with such herbicides as IPC, TCA, CIPC, 1,2,4,5-tetrachlorobenzene, etc., applied on stubble-land prior to fall tillage. The residual toxicity of these herbicides rarely permitted normal cereal crop development the following season. Further experiments were designed to treat the soil prior to, or during, a summer fallow year. This approach lost favor when it became apparent that dormant seeds were not affected. More recently pre-planting, pre-emergence and even post-emergence herbicides have been evaluated. One of the first selective herbicides tested was CDAA, but it was soon demonstrated that the behavior of this herbicide was influenced by soil type, soil moisture and possible temperature, and consequently results were too erratic to warrant general recommendations. Newer herbicides to combat wild oats in cereal crops are being tested annually. One of the new chemicals, 4-chloro-2-butynyl *N*-(3-chlorophenyl)carbamate, tested for the first time in 1958, is of particular interest in that it gave promising results in wheat and barely by post-emergence treatments. However, it is too early to draw definite conclusions on the limited data available on this chemical. Maleic hydrazide has been tested for many years. This herbicide, when applied during the soft-dough stage of wild oats, is quite effective in reducing the germinability of the wild oat seed, in some cases without reducing either the yield or germinability of early maturing barley. Because of the mechanical difficulties involved in such a treatment, MH is still not recommended for farm use.

The control of grass type weeds (other than wild oats) in spring-sown grain has received some attention. Many herbicides have been tested, notably TCA, IPC, MH (in seedling stage), monuron, CIPC, EPTC, dalapon, simazin, amitrol, endothal, etc. Endothal has eliminated green foxtail, without injury to wheat, in several trials. Why endothal has not been recommended for this purpose is not clear. Other herbicides have shown insufficient selectivity to warrant general recommendations.

While the use of herbicides has added materially to control of weeds, it is still recommended that good cultural practices should be employed by producers of spring-sown grain. Thorough seed bed preparation, timely post-seeding and fall cultivations and the use of pure clean seed are still essential to good weed control. Proper summerfallow practices are essential to control and eradicate persistent perennial weeds.

* 1947-56 average.

## FALL-SOWN GRAINS

**L. E. Anderson**

The use of chemicals for weed control in fall sown grains was first reported in the NCWCC in 1945 when studies in Texas and Kansas indicated that wheat, rye and barley could be sprayed successfully with 2,4-D. During succeeding years investigations were directed toward solving problems relative to susceptibility of various fall sown crops, optimum time to spray, effectiveness of various types of 2,4-D, and rates of application. The performance of other herbicides applied to fall sown grains was later reported.

In establishing the comparative tolerance of fall grains to 2,4-D, wheat was found most resistant, barley slightly less resistant, with oats most susceptible. Rye similar to wheat in tolerance.

Numerous studies have been reported with respect to optimum stages of growth for 2,4-D applications. It was early established that injury to wheat from fall applications was expressed by reduced tillering, delayed maturity and incomplete spike exsertion. It was noted that winter barley responded similarly to fall



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applications while oats were more severely injured. Yields of all cereal grains were generally reduced when fall applications were made. Spring applications made from the full tillering stage through early jointing have been most successful in minimizing crop injury. Applications of 2,4-D following the milk stage have caused little injury to fall sown grains.

Although the ester form of 2,4-D has been reported to be more effective in controlling weeds, evidence indicates that it is more injurious to the crop. Optimum rates of application varied from ¼ to ½ lb/A of the ester or ½ to ¾ lb/A of the amine.

During recent years the use of other chemicals for controlling weeds in fall sown grain has been reported. Included are MH, IPC, TCA, TBA and diuron. None of these herbicides were effective under the conditions reported.

On the basis of available evidence, 2,4-D can be used successfully on fall sown crops to control most annual broad-leaved weeds. Applications should be made in the spring from the full tiller stage through early jointing but before the boot stage of growth. Rates of ¼ to ½ pound of 2,4-D acid equivalent per acre of the ester or up to ¾ pound of the amine are suggested dosages. Similar applications made in the fall generally result in crop injury and are not recommended. Preharvest treatment applied at the milk to hard dough stage should be considered an emergency measure to be used only when weeds may seriously interfere with harvesting operations. An application of one pound 2,4-D ester per acre is generally required at this stage even though some crop injury may result. Weed control at this stage is often unsatisfactory. Various broad-leaved weeds and weedy grasses resistant to 2,4-D can be controlled by pre-sowing tillage and by crop rotations. Tillage after plowing should be restricted to control of weeds and preparation of an adequate seed bed.

## SORGHUM

**L. E. Anderson**

The use of 2,4-D for control of weeds in sorghum was first reported as a pre-emergence application before and after planting. From this beginning the emphasis changed to foliar applications where different types of 2,4-D were applied at various rates and dates to varieties of forage and grain sorghum. Recent trends have involved the use of 2,4-D on irrigated sorghum and studies in which new herbicides have been used as foliar and pre-emergence applications.

In general there appears to be a lack of agreement in describing the effects of 2,4-D esters and amines when applied to sorghum. Injuries have been reported under certain conditions where each type of chemical has been used. Lodging, brace root malformation, sterility, delayed maturity, and weak head exsertion have been reported as characteristic injuries where excessive rates of 2,4-D have been applied. Under certain conditions yield was not greatly reduced by the various types of injury. Stages of growth reported as most susceptible to injury were the seedling stage, early boot, and pollination stages. Rates of 1 lb/A and above generally resulted in severe sorghum injury. Forage sorghum appeared more tolerant to 2,4-D than grain sorghum. Varietal differences were evident in both grain and forage sorghums.

Reports of chemicals other than 2,4-D used in controlling weeds in sorghum include MCP, 2,4,5-T, 4-(2,4-DB), CDAA, simazin, monuron and diuron. Of these herbicides MCP, 2,4,5-T, and 4-(2,4-DB) were applied as foliar treatments, while CDAA, simazin, monuron, and diuron were used as pre-emergence. None of these chemicals at the rates used appeared to be more effective than 2,4-D.

At the present time, 2,4-D is the only herbicide suggested for chemical weed control in growing sorghums. If properly used, 2,4-D can be an important tool in a weed control program. With improper use, severe injury to the crop may result.

The use of 2,4-D for weed control in sorghum is recommended only when cultivation is not adequate. Sorghum is most tolerant to 2,4-D when 4 to 12 inches tall, but injury has been known to occur when applications were made during this stage. Severe injury from 2,4-D may occur if applications are made before the three-inch stage and also if applied during the 12-inch through bloom period. Early treatments generally result in lodging and a reduced plant population, while brace root malformation often is characteristic of applications made during the three to 10-inch stage. Delayed maturity, dwarf plants, and sterility are other expressions of injury attributed to 2,4-D. Forage sorghum appears to be more resistant to 2,4-D than grain sorghum. Varietal differences in susceptibility of grain sorghum are evident. Rates of ¼ to ½ pound of 2,4-D per acre are suggested for use on sorghum. Minimum rates should be applied during periods when the crop is most susceptible. If more than ½ pound per acre is necessary to control weeds, the danger of injuring the crop is increased.

Adequate spring tillage prior to planting is essential for weed control in sorghum regardless of cultivation practices used during the previous year.

## FIELD CORN

**Oliver C. Lee**

Following the early successes with both post-emergence and pre-emergence application of 2,4-D for weed control in corn in 1945 and 1946 a number of herbicidal materials have been tested and evaluated. Major research activity related to post-emergence applications of 2,4-D included formulations and dosage trials, spray placement studies, and relationships of stage of corn growth and environmental conditions during the period of 2,4-D application to the degree of observed corn injury and weed control. More recently there have been extensive research trials with pre-emergence herbicides. Research into the problems of pre-emergence use of herbicides have included the screening and testing of herbicides and studies on the time of application as related to date of planting, effects of soil type, soil moisture, and weather conditions, as they affect crop tolerance and degree of weed control. Since annual grasses, not readily controlled by 2,4-D, constitute a major problem in corn, much emphasis has been placed on research that may solve this problem. The evaluation of cultural methods and combinations of herbicidal and cultural control of weeds have been studied. Considerable work has been done to perfect application equipment. As many of the newer pre-emergence herbicides are costly, equipment has been made available to apply over-the-row treatments in order to reduce application costs.

**Post-emergence applications:** 2,4-D is the standard herbicide for the control of broad-leaved weeds in corn. At recommended rates it may be used with safety at all stages of corn growth except at tasseling time. Rates generally used or recommended are ¼ lb/A of the ester formulations and/or ½ lb/A of the amine salt formulations applied in a minimum of 10 gal/A of solution for adequate coverage. Most, but not all, weeds are killed by 2,4-D. Milkweeds, and members of the nightshade group of plants are exceptions. It does not control grasses. Proper timing of 2,4-D applications in relation to weed growth is important. Some species normally killed by dosages that are used in corn may show considerable tolerance in late stages of growth. Directed applications with the use of dropped extensions on sprayers is often desirable when spraying corn over 12 inches in height so that the spray may be applied at the base of the plants and thus reduce the area of corn leaf surface that comes in contact with the 2,4-D. Other forms of 2,4-D as well as several 2,4-D derivatives have



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been tested but have been found, in general, to be less effective than the amine or ester formulations. MCP and 2,4,5-T may be preferred in a few instances due to small differences in selectivity. Certain weeds which appear to be somewhat tolerant to 2,4-D may be killed by 2,4,5-T.

Salts of dinitros have found only limited usage. DNBP at 3 lb/A may be used for the control of weeds in corn when applied before the two-leaf stage of growth. Its use has been limited due to an occasional instance of temporary stunting of corn and danger of greater injury when high temperatures follow applications.

Substituted ureas when used as early post-emergence treatments at rates of 1 to 3 lb/A have given favorable weed control but frequently cause injury to corn. Amitrol, in experimental trials, has shown promise for the control of weeds in corn when applied at early stages of growth. Some injury to corn has been observed.

CIPC, TCA and dalapon have been tried as directed sprays to control grassy species. To date no sure method has been found for the application of directional sprays without some injury to corn.

Results of 1958 research may be summarized as follows: Esters of 2,4-D, 2,4-DB, MCPA, and MCPB provided excellent control of weeds when applied to corn 6 inches high. Corn injury was slight. In another test, treatments with 2,4-D amine at 7 or 13 days after emergence were equally effective in controlling weeds. Amitrol gave generally fair weed control when applied at a rate of 1 lb/A. Corn injury apparently varied with the stage of application, being more severe at the 4-to-6-leaf stage than at either the 2-leaf stage or at emergence. Simazin was tested as an early post-emergence treatment and found to be effective at rates of 2 to 4 lb/A depending again on the stage of application. Chlorinated benzoics continued to show promise.

**Pre-emergence applications:** Esters of 2,4-D are still included in most trials as one of the standard pre-emergence chemical treatments, and have gained some acceptance as a practical measure. Recommended rates vary from 1 to 4 lb/A depending on the locality and soil type. Rates of 1½-2 lb/A constitute the usual treatment on mineral soil. 2,4-D has given satisfactory control of broad-leaved weeds and some degree of annual grass control with a minimum of corn injury. When conditions are favorable, control is usually maintained for a 3-5 week period. In general, most investigators have favored the ester forms over the more water-soluble amines. Several other forms of 2,4-D, including sesone, several salts and formulations of the free acid, 2,4-DEB, the ethyl phosphite, the cellosolve sulfate, the acetanilide, and the acetamide, have shown no clear-cut advantage over esters and/or amines for pre-emergence weed control. 2,4-D acetamide and tris-(2,4-D ethyl) phosphite are still being retained in some experiments. Reports indicate that control ranges from excellent to less effective than standard formulations.

The results with MCPA have been encouraging. A rate of 2 lb/A has given weed control comparable to 2,4-D, but again the treatment offers no particular advantage.

The sodium salt of 2,4,5-T and its derivatives, 2,4,5-T acetamide, silvex, and 2,4.5-T ethyl sulfate have, for the most part been ineffective as pre-emergence herbicides. Two investigators reported silvex as being somewhat superior to 2,4-D. Subsequent investigations were less encouraging, however.

Several other phenoxy herbicides such as 3,4-DA and the butyric analogs have been included in isolated experiments from time to time. There has not been sufficient testing of these materials to warrant individual consideration.

The disodium salt of endothal was given some consideration as a pre-emergence herbicide in the period 1948-50, as was EXD. Treatments involving 2 and 4 lb/A of endothal and 5 to 20 lb/A of EXD were uniformly ineffective and unsatisfactory. Other treatments prevalent during this time were DCU (2-8 lb), ammonium thiocyanate (22-88 lb). calcium cyanamid (150-600 lb) and the sodium salt of PCP (8-24 lb). Of these, the sodium salt of PCP at rates of 15-20 lb/A was the most effective, considering both weed control and corn tolerance.

The "dinitro" herbicides were tested extensively as possible pre-emergence herbicides for the North Central Region. Of the materials tested, the alkanolamine salt of DNBP was given the most consideration. Fair to excellent control of weeds was obtained at 6 lb/A with little or no damage to corn. High temperatures following application have been found likely to cause severe crop injury. The treatment has not gained wide acceptance.

Carbamates in general will give pre-emergence control of grassy weeds and many attempts have been made to use the materials for weed control in corn. IPC and CIPC were the first to be tested. Some conflicting results on corn injury were reported with injury ranging from none to a 50% reduction in yield for the same rates. In general, 4-8 lb/A of both IPC and CIPC gave good control of annual grasses with more than allowable corn injury. Broadleaved weeds are not effectively controlled.

One report for 2-(1-chloropropyl) *N*-(3-chlorophenyl)-carbamate states that it is equal to 2,4-D in control of weedy grasses and superior in the control of broadleaved weeds with no injury to corn at rates of 8 and 12 lbs/A.

CDAA at rates of 4 lb/A and up has given good control of annual grass weeds with little control of broadleaves. CDAA was found to be slightly superior to CDEA and greatly superior to CDEC. No corn injury was reported for either CDAA or CDEA. CDEC caused some stunting at higher rates. Preliminary data indicate that CDAA is most effective when applied to a dry soil. A related material, 2-chloro-*N*-ethyl-*N*-phenylacetamide, was found to be similar in effectiveness to CDAA.

Still another group of herbicides investigated for pre-emergence activity are the substituted ureas. One of the earliest considered was DCU. A few years later fenuron was tested with variable results. Some investigators reported outstanding weed control with no injury to corn, at 2 and 4 lb/A. Later testing revealed the possibility of severe corn injury and the material is no longer being tested. Monuron also proved to be injurious. Corn was generally damaged at rates above 2 lb/A. although good weed control was usually obtained. Diuron gave good weed control with a minimum of corn injury in 1954. Results in 1956 were erratic, with results ranging from no weed control to good control. Corn injury varied and was apparently unpredictable. Neburon has been tested extensively in 1956-58. Rates from 2 to 6 lb/A have provided excellent weed control with no reports of corn injury thus far.

The sodium salts of TCA and MH were applied as pre-emergence treatments to corn at minimal rates of 4 and 8 lb/A. These and higher rates reduced corn stands as well as the vigor of the remaining corn. Weed control varied from excellent for TCA to none for MH.

Reports on amitrol as a pre-emergence herbicide are limited but one investigator obtained outstanding weed control at 2 and 4 lb/A.

NPA has been somewhat erratic in its effect on weeds. Rates as high as 6 lb/A have been reported less effective than 2,4-D at 1.5 lb/A. On the other hand good control was obtained with 2, 4, and 6 lb/A in another experiment with no injury to corn.

Two reports for 3,4-dimethylbenzophenone in 1957 indicate some weed control at 12 lb/A with no injury to corn. In one of the experiments the material gave good control of broadleaved weeds but not of millet.

Salts, esters, and acid formulations of 2,3,6-TBA, 2,3,5,6-TBA and mixtures of these with and without additional isomers are being tested as pre-emergence herbicides. Weed control obtained with these materials has been very similar to that obtained with 2,4-D, with slight injury to corn in some cases. In general, the most effective polychlorinated material has been 2,3,6-TBA. A related material, 3,4-dimethylbenzoic acid, apparently was not satisfactory in one test. One abstract in 1958



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for 2,5-dichloro-3-nitrobenzoic acid reported a reduction of 95% or more in weed population at 4, 6 and 8 lb/A.

EPTC used at rates of 2, 4 and 8 lb/A gave good weed control with a minimum of injury to corn in 1957. It appears to control broadleaved weeds less effectively than grasses. Degree of both injury to corn and weed control varied greatly. Increased activity is obtained when the material is incorporated into the soil during application. Variability in effectiveness may be due to differences in soil moisture content. The 1958 results are similar to those obtained in 1957.

The first of the triazine derivatives to be tested (2-chloro-4,6-bis(diethylamino)-*s*-triazine) is the least effective. Rates as high as 12 and 20 lb/A were required to give complete control of weeds. Simazin has generally been capable of eliminating the weeds in corn at a rate of 2 lb/A. In 1956 and 1957 excellent results were reported with simazin. excellent weed control and no injury to corn. More erratic and less satisfactory weed control was obtained in 1958. Unfavorable soil and moisture conditions are believed to be the cause of failures. All of the other triazine derivatives tested, with the possible exception of 2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine (Atrazine) have been less effective than simazin in performance on weeds. Atrazine was superior to simazin in 1958 and in one experiment no weeds survived even at 1 lb/A. In general corn is quite tolerant to all of these materials.

Results in 1958 revealed the following trends: In general rates of simazin greater than 2 lb/A were required to obtain 90% or better weed control especially with respect to grasses. In one report excellent control was reported from 1 lb/A. Results from CDAA were erratic, with one report of poorest weed control resulting from application to a dry soil. EPTC continued to look favorable, but there were several indications of corn injury at herbicidal rates. Results were poor where rain followed treatment. Incorporation into the soil increases the effectivenesses of the chemical. 4 lb/A incorporated was similar to 8 lb/A unincorporated in both weed control and crop injury. A comparison of different phenoxy compounds for pre-emergence weed control in corn showed the "butyrics" decidedly inferior. The differences between the ester, amine and acid were small and inconsequential. Favorable control of weeds was obtained with 2,3,6-TBA with injury to corn also reported. In isolated tests satisfactory results were obtained with neburon, diuron, 2,3,6-TBA, Atrazine, and 2,5-dichloro-3-nitrobenzoic acid.

**Cultural control:** If we concede that the principal purpose of cultivation in corn is for the purpose of weed control, equipment best adapted to do this job of destroying weeds should be used. Shallow cultivations, one or two, during the season in combination with spraying with 2,4-D is a common practice. The use of herbicides in conjunction with cultivation, rather than to rely on them alone, appears at present to be most practical. More information relative to losses due to weeds in corn is needed to determine the most economical procedure of growing corn. Some work is under way to determine the amount of the crop loss from various degrees of weed infestation and the effect of removal of weeds at various stages of growth. Such information is vital to planning the most economical program of weed control in corn.

## FLAX

**R. G. Robinson**

Flax does not compete well with weeds and is much inferior to small grain in this respect. The crop tends to be grown in areas where midsummer weed growth is not extremely vigorous, and growers have generally considered flax a crop for fields on which there is no serious weed problem. These precautions are still desirable, but improved cultural practices and herbicides developed in the last 12 years have greatly extended the potential range of flax production and have greatly reduced the risk.

Trials during the "forties" of weed-free vs. weedy flax showed that substantial yield reductions may occur with only moderate infestations of weeds. This information stimulated research that led to the development of the special weed control practices that are now being used extensively. Cultural and chemical weed control recommendations are now followed on a large percentage of the commercial flax acreage.

The same characteristics that make flax a weak competitor with weeds make it a good companion crop for establishing forage legumes and grasses, provided weeds are controlled. The development of herbicides to which flax and forage legumes and grasses are tolerant has enabled growers to exploit the advantages of flax as a companion crop. However, in some of the western and northern parts of the area, seedling legumes compete strongly with flax and interfere with harvest so flax is not used as a companion crop for forage legumes in these areas.

Flax should not be sown on fields heavily infested with weed species not susceptible to the herbicides recommended for flax, unless the extent of the infestation is first reduced by tillage, proper crop sequence, competitive crops, or herbicides.

**Cultural practices:** Good crop sequences for controlling the predominant species of weeds and timely tillage are the basic practices for weed control in flax. Weed control in all crops in the sequence or rotation is beneficial to flax. Extensive trials have emphasized the value of preventing weed seed production in corn, soybeans, and other cultivated crops followed by relatively shallow surface tillage in preparing the seedbed for flax. When small grain precedes flax, early after-harvest tillage, "August plowing," to control perennial weeds, prevent weed seed production, and stimulate weed seed germination in late summer and fall is recommended except where after-harvest tillage results in serious wind erosion.

Delayed sowing of flax to permit spring tillage for wild oat control is successful in some areas, although the delay is sometimes detrimental to flax. For delayed sowing, early maturing varieties such as Marine, Bolley, Sheyenne, or Raja are recommended.

Results of trials in which half of the flax seed was drilled in one direction and the remaining half at right angles to the first direction were erratic, leading to the conclusion that it was not an economic practice. Drilling flax gave better weed control than broadcasting. Extensive trials in the more humid part of the area showed that flax drilled in rows six inches apart was less weedy than flax drilled in rows seven inches apart. Rate of sowing and stand trials showed that a full stand of flax was essential in obtaining satisfactory weed control with herbicides and cultural practices.

Use of the spike-tooth harrow or weeder on weeds in the "white" stage in young, established flax gave good results when weather was favorable and timing perfect, but herbicides have generally lessened interest in and the need for this practice.

**Herbicides.** When the North Central Weed Control Conference was organized, a dinitro herbicide applied in 80-100 gallons of water per acre was the only treatment recommended for flax. At first, flax was rated as susceptible to 2,4-D, but later seed flax was found tolerant to low rates. About the same time, low volume applications were found practical. These developments resulted in the spraying of millions of acres. Further research showed MCPA to be less injurious than 2,4-D to flax. Both herbicides are now extensively used for non-grass weeds.

Varietal differences in the response of flax to 2,4-D were of sufficient magnitude to warrant lower rates of application on susceptible varieties like Minerva. At the present time, commercially important varieties are



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not sufficiently different in response to herbicides to warrant spray recommendations on a variety basis.

Stage of growth in relation to tolerance was intensively studied, but consistently tolerant or susceptible periods were not found during the vegetative development period of established flax. Apparently environmental factors affecting tolerance are of equal or greater importance than morphologic development up to bud stage. Flax should be sprayed with MCPA or 2,4-D as soon as there is sufficient emergence of susceptible weeds to make spraying practical. This will usually be when the flax is 2-6 inches tall. Do not spray flax with MCPA or 2,4-D during the period between early bud and the stage when 90 percent of the bolls have formed.

Spraying may reduce yields of seed and straw unless weed competition is reduced sufficiently to offset injury from spraying. MCPA is less likely than 2,4-D to injure flax and is therefore the preferred material. Use 2 to 4 oz/A of MCPA or 2,4-D in amine formulations for wild mustard. Use 4 oz for lambsquarters, ball mustard, stinkweed, cocklebur, marsh elder, and ragweed although in some areas 5-6 oz are necessary.

Good kills of moderately resistant weeds are generally not obtained, but by using higher rates of application these weeds can be held in check and their seed production largely prevented. For *heavy* infestations of wild buckwheat, smartweed ,red-root pigweed, Canada thistle, or perennial sowthistle, use 5 to 8 oz/A MCPA or 2,4-D in amine formulations or 5 to 6 oz MCPA ester. Use 2,4-D ester, at 4 to 5 oz/A or MCPA, ester, at 6 oz for Russian pigweed and Russian thistle. Even at these higher rates, control of moderately resistant weeds may not be satisfactory and flax is likely to be injured.

Recently flax has been found tolerant to ½ lb/A or more of 4-(2,4-DB) or 4-(MCPB). However, the greater cost of these herbicides indicates that their potential use will be where flax is used as a companion crop for forage legumes.

Work in testing chemicals for selective control of grass weeds in flax led to the recommendation of TCA in 1952 and dalapon in 1958. TCA at 5 lb/A or dalapon at 1 lb/A will kill green foxtail, yellow foxtail and giant foxtail in young flax. The flax should be at least 2 inches tall and the weeds emerged but less than 2 inches tall for best results. TCA or dalapon can be applied in mixture with MCPA or 2,4-D to kill susceptible grass weeds and susceptible non-grass weeds with one application, but neither this mixture nor the grass killers alone should be applied after early bud stage.

When flax is used as a companion crop to establish alfalfa, red clover, alsike clover, Ladino clover, birdsfoot trefoil, timothy, meadow fescue, bromegrass or crested wheatgrass, use MCPA or 2,4-D as directed for susceptible weeds in flax except that legume seedlings should be at least 2 inches tall. Sweetclover seedlings will probably be killed if the flax is sprayed with MCPA or 2,4-D. TCA or dalapon can be used on flax sown with alfalfa, sweetclover, or birdsfoot trefoil but will probably kill forage grasses and seriously injure red and alsike clovers.

Large or consistent differences in flax injury due to spray volumes were not usually found. However, the trend is for less injury with 10-20 gal/A than with lower volumes especially when esters, grass killers, or high rates are used.

Many chemicals have been screened for selective control of wild oats in flax. IPC and CIPC after some success were not satisfactory. CDAA has been erratic; it may injure flax and fail to control weeds if an extended period of cool weather follows application. EPTC, pre-emergence, is very promising. Incorporation in the soil permits the use of much lower rates. 4-chloro-2-butynyl *N*-(3-chlorophenyl)carbamate, post-emergence shows considerable promise.

MH at rates of ½ to 1 lb/A sprayed on wild oat plants at a critical stage (milk to early dough) has destroyed the viability of wild oat seed and greatly reduced the viability of the harvested flax seed. A rotation study has shown that spraying the crops on a field every year will in time control wild oats. Uneven development of wild oats, reduced viability of the harvested crop seed, expense. and poor spray coverage in lodged crops are some of the practical ilimitations to this method.

## SOYBEANS

**Fred W. Slife**

Weeds have presented one of the greatest hazards to good soybean yields in the North Central States. In addition to the loss in yield from competition for the essentials of growth, weeds can cause substantial harvesting losses and unnecessary wear on harvesting equipment. Planting soybeans in rows so they can be cultivated has lessened the weed hazard but has not eliminated it. Several states have recently reaffirmed the value of the rotary hoe in soybean production. These studies have shown that in the majority of years timely hoeing plus cultivation will give adequate weed control.

Soybeans are one of the most sensitive crops in terms of soil temperature. Planting in cool soils slows germination and allows weeds to germinate faster while in warm soils the converse is true. Soybeans are good weed competitors if they germinate first.

There has been a continuing interest in chemical weed control for soybeans. Practically all chemicals available for selective weed control have been tested for use in soybeans. Unfortunately, only a few have shown any promise.

**Post-emergence sprays.** Soon after the introduction of 2,4-D, this material was evaluated as a post-emergence spray for soybeans. Results indicated that in general soybeans were too sensitive to the chemical. Later work with various formulations of 2,4-D, 2,4,5-T. and MCP failed to point out any usage of these materials for the soybean crops.

Salts of dinitros have found some promise as post-emergence sprays. DNBP at 3 lb/A applied to soybeans in the crook stage has not resulted in injury to the crop and in general has given good weed control. It has been shown, however, that weed control varies with temperature and poor weed control results when cool temperatures prevail at application time.

None of the other available weed control chemicals have shown any particular promise as post-emergence sprays for soybeans because of the susceptibility of the crop.

**Pre-emergence sprays.** Over the past 10 years, a considerable amount of research information has been accumulated on the effectiveness of DNBP, CIPC, and NPA for weed control in soybeans. Injury has been reported from all 3 chemicals and weed control has been reported from good to erratic. Each chemical seems to have a slightly different selectivity for weed species. DNBP. CIPC, and NPA are not presently being used widely over the north central states but all 3 are being used in some sections.

CDAA, a newer pre-emergence material, has been reported as being specific for the control of annual grass with little or no broadleaf control. Effectiveness for grass control with CDAA has been reported from good to erratic. There have been no consistent reports of injury to soybeans from this compound. CDAA is presently recommended over a larger area of states than DNBP, CIPC and NPA. The sodium salt of PCP, although an older material, has shown promise for weed control in soybeans without soybean injury. Newer compounds such as EPTC, TBA, and triazine compounds appear to offer little promise for soybeans because of injury.



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## FIELD AND CANNING PEAS

**J. J. Sexsmith**

Cultural methods have been and will continue to be important in the control of weeds in peas. Reasonable control of most annual weeds can be obtained by thorough seed-bed preparation.

The introduction of various chemicals since 1944 has led to considerable testing over the last number of years with mixed success. Research has centered on the use of selective post-emergence herbicides, but a great number of herbicides have been tested for pre-planting and pre-emergence use. Only a relatively few materials have proved useful for controlling weeds without causing undue injury to peas. Spray volume has been found to influence the degree of crop injury, and some varietal differences have been established.

Work is needed to determine losses resulting from different levels of weed infestation, to improve the control obtained from fall and spring tillage operations, and to determine more exactly the varietal reaction to the various useful herbicides. Continued testing of newly introduced herbicides is necessary if a wider range of weeds is to be controlled by chemicals that will not injure peas.

**Cultural practices.** Good cultural and cropping practices with preceding crops will do much to reduce losses in the pea crop from both annual and perennial weeds. Pre-seeding tillage and good seed-bed preparation can reduce the potential infestation of annuals but will not be of much value for growth suppression of perennial weeds.

**Herbicides.** The use of various types of dinitro materials has been recommended since 1946. Present use is more or less restricted to the amine forms of DNBP. DNBP applied as a pre-emergence treatment at 6 lb/A will control both broadleaf and grass annuals (except wild oats). Good results can be expected only if good moisture conditions prevail. DNBP, at ¾ to 1¼ lb in 40 gallons of water per acre, will control broad-leaf annual weeds if applied when the weeds are in the seedling stage immediately prior to pea emergence. In some localities DNBP amine, applied at rates between 1 and 3 lb/A, has given good control of annual grasses in the 1- and 2-leaf stage, regardless of the stage of pea growth, without causing reduction in pea yields.

Wild oats may be controlled with IPC at a rate of 4 to 6 lb/A. The material should be applied as a spray to the soil surface and thoroughly disked-in to a depth of 2 or 3 inches immediately prior to the planting of the pea seed. To be successful, the treatment should be made to non-lumpy soil that is moist or that can be irrigated.

TCA at 4 to 6 lb/A can be used for the control of foxtail in field peas but *not* in canning peas. Treatment should be applied when the foxtail plants are in the 2- to 3-leaf stages.

The sodium, potassium, or amine salts of MCPA, at rates between 2 and 6 oz/A, can be used to control broad-leaf annual weeds in peas from 3 to 7 inches in height. If an amine of MCPA is used, the spray volume should be increased to between 15 and 30 gal/A. Flower-bud development of Canada thistle can be controlled by MCPA at rates between 4 and 6 oz/A.

The addition of dalapon at 1 lb/A to MCPA used for the control of broad-leaf annuals has been suggested for the control of annual grass-weed infestations.

Tests conducted during the past three seasons have proved that peas are quite tolerant to a 20- to 24-oz rate of 4-(MCPB) and that such rates will give reasonably good control of a number of annual broad-leaf weeds as well as provide excellent top-growth control of Canada thistle and perennial sowthistle.

## FORAGE LEGUMES

**P. F. Sand**

**Seedling establishment.** Since 1948 much effort has been directed to the use of herbicides in the establishment of seedling legumes using herbicides to control weeds. Legumes most frequently used in the trials were alfalfa, sweet clover, and red clover. Alsike clover, Ladino clover, Korean lespedeza and birdsfoot trefoil were used to a lesser extent.

From 1948 through 1954 major herbicides included 2,4-D amines and esters, 2,4,5-T, MCPA amine and ester, 4-chlorophenoxyacetic acid, IPC, CIPC, DNBP, KOCN, monuron, dalapon, TCA, PCP, and endothal. In 1955 many investigators included 4-(2,4-DB) amine and ester and 4-(MCPB) amine and ester in their trials. In 1957 and 1958 EPTC was used.

Results with formulations of 2,4-D, 2,4,5-T, and MCPA were variable and ranged from good weed control with slight injury to legumes to poor weed control and severe legume injury. Generally, the esters were more detrimental to the legumes than were the amine formulations. Rates of 2,4-D of ¼ lb/A or less did not always give injury. However, in some tests, even at such low rates, 2,4-D gave a high percentage reduction in stand of legumes while weed control was not always satisfactory. Occasionally ½ to 1 lb/A of 2,4-D failed to cause injury to some legumes. Injury was usually less if the legume had a canopy of a nurse crop or weeds at the time of application of the herbicide. However, one investigator consistently reported excellent control of weeds with little or no injury to alfalfa when treatment with 2 oz/A of butoxy ethanol ester of 2,4-D was made at a very small stage of growth (1½ inches tall) without a nurse crop.

There was no consistent pattern as to whether MCPA was more or less injurious to legumes than 2,4-D. The most severe injury was about equally divided between the two chemicals. Some investigators reported that 2,4-D was more harmful than MCPA to legumes in their experiments while others would report the reverse of this.

Some of the legumes were more tolerant than others to the hormone type herbicides. For example, with few exceptions, of all legumes tested sweet clover was the most susceptible to 2,4-D, MCP, and 2,4,5-T. Ladino clover, red clover, alsike clover, and lespedeza were generally more tolerant than alfalfa or sweet clover. Annual lespedeza tolerated up to ½ lb/A of 2,4-D provided treatments were made on rapidly growing plants four to six inches tall. Earlier or later applications seriously reduced yields.

Results with IPC and CIPC were erratic. In some tests they gave good weed control, as pre-emergence treatments at 3 to 4 lb/A, without injury to legumes. On the other hand, some reports showed that these chemicals caused severe injury to legumes and others reported unsatisfactory weed control. They did not appear to be satisfactory for control of weeds in seedling legumes.

DNBP applied post-emergence at ½ lb/A to 4 lb/A also gave erratic results. Some investigators reported excellent weed control with little injury to alfalfa while others reported poor weed control and severe injury to alfalfa. In one test birdsfoot trefoil was eliminated with 3 lb/A of DNBP when applied at the cotyledon stage.

Monuron at 1 lb/A eliminated Ladino clover, red clover, birdsfoot trefoil, alfalfa, and lespedeza in one test. Another investigator reported no injury to alfalfa by monuron at 1 and 2 lb/A but severe injury to alsike clover, sweet clover, Ladino clover, and red clover.

A single report showed that endothal at 4 lb/A did little damage to red clover, but injured sweet clover, alfalfa, Ladino clover, and alsike clover. Pentachlorophenol at 8 lb/A did not injure sweet clover, Ladino clover, red clover, alsike clover, or alfalfa. A pre-emergence application of KOCN did not damage alfalfa or sweet clover but failed to control the weeds.

Dalapon and TCA have given good control of annual



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weedy grasses in seedling legumes. The legumes most tolerant of these two chemicals were alfalfa, sweet clover, and birdsfoot trefoil. Red clover, alsike clover, Ladino clover, and lespedeza were severely injured or killed by dalapon and TCA although Ladino clover was affected less than red or alsike clover. One investigator reported that some varieties of Ladino clover were more tolerant to dalapon than others.

There appeared to be no varietal difference in tolerance of alfalfa (Cossack, Grimm, Ranger, and Ladak) to TCA at 10 lb/A. At this rate, however, varieties of sweet clover responded differently to TCA. Evergreen sweet clover was injured more than Madrid, commercial white, or commercial yellow.

In one experiment TCA at 5 to 20 lb/A applied as a pre-emergence treatment severely reduced the stands of alfalfa and sweet clover. Post-emergence applications (2½ inches tall) of 15 and 20 lb/A substantially reduced the stands of alfalfa and sweet clover. In another experiment pre-emergence treatments of dalapon at 3 lb/A and TCA at 8 lb/A seriously reduced stands of alfalfa and sweet clover while early post-emergence treatments had little effect on either legume.

Post-emergence treatments of dalapon at 2 lb/A and TCA at 5 and 7 lb/A applied when alfalfa, sweet clover, and birdsfoot trefoil were 1 to 2 inches tall gave excellent control of weedy grasses with generally little or no damage to the legumes.

The butyric homologues of 2,4-D and MCP have been used successfully at rates of ½ to 1 lb/A to control broad-leaved weeds in seedling alfalfa, birdsfoot trefoil, red clover, and alsike clover with little or no injury to the legumes. Many investigators reported that 4-(MCPB) was more toxic to legumes than 4-(2,4-DB) while a few reported 4-(MCPB) was less injurious, especially to alfalfa and sweet clover, than 4-(2,4-DB). Post-emergence treatments gave more effective weed control than pre-emergence treatments. Serious injury to alfalfa was reported from 2 lb/A of 4-(2,4-DB) applied as a pre-emergence treatment. One report indicated that seedling sweet clover was almost completely eliminated by a post- emergence treatment of 4-(MCPB) and 4-(2,4-DB) at 1 lb/A.

Weed species effectively controlled by 4-(2,4-DB) and 4-(MCPB) were *Kochia*, smartweed, Russian thistle, lambsquarter, pigweed, *Croton* spp., *Diodia* spp., stinkweed, ball mustard, tansy mustard, and wormseed mustard. The tops of Canada thistle, field bindweed, and curled dock have also been killed by 4-(MCPB) and 4-(2,4-DB). Velvet leaf was resistant.

A combination of 4-(2,4-DB) at 1 lb/A plus dalapon at 2 to 3 lb/A has successfully controlled both broad-leaved weeds and weedy grasses in seedling alfalfa and birdsfoot trefoil. In some cases more injury to the legume was caused by the combination of the two herbicides than from either alone. One test indicated there was no difference in tolerance of five varieties of alfalfa (Buffalo, Grimm, Ranger, Ladak, and Vernal) to dalapon and 4-(2,4-DB) or to a mixture of these two chemicals.

EPTC gave excellent control of weedy grasses in seedling alfalfa, red clover, birdsfoot trefoil and lespedeza with little or no injury to the legumes. Best results were obtained when EPTC was applied at 2 to 3 lb/A as a pre-planting treatment and immediately worked into the soil. EPTC was more effective on weedy grasses than on broad-leaved weeds although some control of broad-leaved weeds was obtained.

**Established stands.** Weed control in established stands of alfalfa, red clover, Ladino clover, and sweet clover with 2,4-D and MCPA caused varying degrees of injury. Generally, treatments made early in the spring when the plants were dormant did not affect the legumes as much as later treatments. However, treatment with these herbicides at rates higher than ¼ lb/A frequently caused severe injury to the legumes, even when applied in the dormant stage or just after the legumes had started to grow.

Dinitro did a good job of controlling weeds in established legumes with little injury from rates up to 3 lb/A.

Established stands of alfalfa, sweet clover, and birdsfoot trefoil were generally tolerant to applications of TCA at rates of 5 to 7 lb/A. For control of many annual weedy grasses, the TCA was applied when grasses were from emergence to 2 inches tall. Ladino clover, alsike, red clover, and lespedeza were injured or killed by TCA treatments.

Treatment of established stands of alfalfa with amine salt of 4-(2,4-DB) up to 2 lb/A from the ½ inch stage in March to the 24 to 28 inch stage in May did not reduce forage yields.

**Summary of 1958 results.** One of the most widely used chemicals in 1958 legume tests was EPTC. Eight of the fourteen abstracts submitted contained information about this chemical. Results were excellent in most tests. Good weed control was obtained with little or no injury to legumes. However, under extremely wet conditions weed control did not last throughout the season. Pre-planting, incorporated treatments were much more effective than pre-emergence applications. Rates of 2 to 3 lb/A incorporated as pre-planting treatments gave better weed control than 6 lb/A applied as a pre-emergence treatment. Weedy grass control was better than broad-leaved weed control, but in most cases some broad-leaved weed control was obtained. Legumes used in the experiments were not injured or only slightly stunted by rates of EPTC ranging from 1 to 15 lb/A. They were alfalfa, birdsfoot trefoil, sericea lespedeza, *Lespedeza daurica*, Korean lespedeza, medium red clover, and crown vetch. Stands of Korean lespedeza were slightly reduced from the check while stands of crown vetch and sericea lespedeza were nearly doubled compared to the check.

Application of 8 lb/A of 4-(2,4-DB) butyl ester to seedling alfalfa 4 to 6 inches tall gave no injury. Sweet clover treated at the same stage was severely injured by 4-(2,4-DB) at 1 lb/A. Both legumes showed severe damage from MCPA at rates above 1 lb/A and appreciable damage at rates above 0.5 lb/A. Mixtures of dalapon and 4-(2,4-DB) damaged alfalfa more than when each was used separately.

*Bromus tectorum* was successfully controlled by fall applications of 8 lb/A of CIPC and 2 lb/A of monuron in an established stand of alfalfa. Simazin at 3 lb/A applied in the fall and early spring gave good control of the brome but caused severe reductions in yield of alfalfa. However application of simazin on April 9 did not affect alfalfa yield. Spring applications of monuron at 1 and 2 lb/A and dalapon at 4 lb/A also reduced alfalfa yields but gave good control of the weedy brome.

Quackgrass was nearly eliminated in an established stand of alfalfa by 4 lb/A of dalapon applied in the spring for 2 years while 2 lb/A rate was not as effective. Spring application of dalapon caused a reduction in yield of the first cutting of alfalfa, but no reduction in yield was noted in later cuttings. Fall application of dalapon caused slower than usual growth in the spring, but the alfalfa soon recovered.

Application of TCA and dalapon at 3 and 8 lb/A nearly doubled seedling stands of sericea lespedeza and *Lespedeza daurica* while stands of Korean lespedeza were somewhat less than that of the check.

DNBP at 2 and 2 lb/A applied in the spring to an established stand of alfalfa and ryegress and 4-(2,4-DB) at ½, 1, and 2 lb/A applied at various stages of growth had no effect on yield of either crop.

## HERBACEOUS WEEDS IN PASTURES AND MEADOWS

**M. K. McCarty**

Any attempt at weed control in pasture land should be accompanied by proper management practices.

Spraying with 1 to 2 lb/A of 2,4-D, 2,4,5-T or a mixture of the two gives better control of more kinds of

weeds by a single application than is obtained by a single mowing treatment. Spraying during active growing condition of the weeds is essential for good results. Repeated treatment for two or more years is usually necessary. Increased production of desirable forage and improvement in grass stands following treatment have been reported. In general, these chemicals may be used at rates necessary for weed or brush control without appreciable injury to the grasses.

Mowing has been a recommended practice for controlling many kinds of weeds if done at the right time for a 2-4 year period. However, evidence from one long-term experiment indicates that mowing annually for 8 years in early June or early July did not significantly reduce the numbers of ironweed and several other perennial species. In general, mow herbaceous weeds in the early bud to blossom stage.

In very weedy pastures where good perennial grasses are thin, reseeding may be the most important improvement practice. To be successful, a good, firm seedbed should be prepared for any reseeding and fertilizer needs should be taken care of at time of seedbed preparation. Protect new seedlings from grazing until established and graze moderately thereafter. Plowing or intensive surface tillage and seeding to adapted grass and legume species where practicable, will usually eliminate many of the perennial pasture weed species.

Seedlings of perennial grasses may be advantageously treated with 2,4-D if the broad-leaved weeds are a problem and if the land is not heavily infested with seeds of the weedy anual grasses. Rates up to ¾ pound per acre may be used after the grass seedlings have reached the 2 to 4-leaf stage of growth. Reports indicate the cool season grasses are more tolerant of the spray in the seedling stage than the warm season grasses. Where weedy annual grasses are the major problem, repeated clipping, if necessary to prevent all seed production, may be used successfully.

Monuron at 3 lb/A has given good control of annual bromes in established warm season grass stands when treated in the fall. Rates as high as 10 lb/A were used on big bluestem, indiangrass and switchgrass with no adverse effects.

## SUGAR BEETS

**R. N. Andersen**

Sugar beets are grown to some extent in most of the states and provinces in the NCWCC region. The major sugar beet growing areas in the region are the Red River Valley area (northwestern Minnesota, eastern North Dakota and southeastern Manitoba), central and western Nebraska ,east central Michigan, northwestern Ohio, north central Iowa, southeastern Minnesota, and southwestern Alberta.

The major weed problem in the western portion of the Region is annual grasses, mainly *Setaria sp.* and *Echinochloa crusgalli.* Another grass, wild oats, is also a problem in the Red River Valley area and in Alberta. Annual broadleaf weeds are the major problem in the eastern areas. By this rather arbitrary division of the Region on the basis of major weed problems, it is not meant to imply that broadleaf weeds are not a problem in the western areas or that grasses are not troublesome in the eastern areas.

Weed control in sugar beets was first considered in the North Central Weed Control Conference in 1947. The successful use of post-emergence treatments of concentrated NaCl solutions for the control of broadleaf weeds was reported. Work conducted on sugar beets outside the conference area, in Colorado and California, was also reported. This work dealt with the use of oils and fortified oils applied post-emergence to weeds but pre-emergence to sugar beets. This method showed little promise in the North Central area where beets normally emerge before or at the same time as the weeds. The succesful use of the finger weeder (also called the pencil weeder, bean weeder, and weeder mulcher) for removal of small weeds from emerged beets was also discussed in 1947.

In succeeding years numerous compounds were tested for weed control in sugar beets. One of the more promising chemicals tried in 1948 was TCA which gave control of annual grasses when applied as a pre-emergence treatment. In 1950 the NCWCC recommended TCA at 5 to 10 lb/A as a pre-emergence treatment for control of *Setaria* sp. in sugar beets and concentrated solutions of NaCl for post-emergence control of some species of broadleaf weeds. The use of TCA as an emergency treatment for control of annual grasses after beet emergence was added to the recommendations in 1952.

Pre-planting soil incorporation treatments were introduced in 1951 with the report of successful control of wild oats and volunteer small grain with IPC disked into the soil. In 1953 the use of IPC disked in prior to planting beets was added to the recommendations as a method of controlling wild oats. In this year dalapon showed promise for control of emerged annual grasses. Testing of dalapon as a post-emergence treatment for the control of emerged annual grasses, including wild oats, was continued. In 1957 the use of dalapon for control of annual grasses in beets was added to the recommendations of the NCWCC. EPTC showed promise in 1957 for control of annual grasses including wild oats and also gave broadleaf weed control. Soil incorporation appeared to increase efectiveness. Beets showed considerable tolerance.

In 1958 EPTC controlled grass and broadleaf weeds particularly if incorporated prior to planting beets. Stand reductions and early stunting. which was later outgrown, were reported. Endothal, which has given control of broadleaf and grass weeds at some locations in the North Central area when applied as a pre-emergence or soil incorporation treatment, was used commercially this year, primarily in Colorado. This compound may find commercial use in some locations in the NCWCC area.

**Present Status of Weed Control in Sugar Beets.**

Beets are grown under diverse soil and climatic conditions in the Conference area. Local recommendations should be followed for all weed control methods.

**Cultural control.** Recommended crop rotations and methods of cultivation suited to conditions within the particular sugar beet growing area are still the principal means of weed control. The use of the finger weeder for killing small weeds, particularly grasses, in emerged beets has increased. More recently, the rotary hoe has been used for the same purpose as the finger weeder. Weed control in the row is facilitated by mechanical thinners which are used increasingly in the North Central area. Hand labor, mostly long handled hoeing, is still necessary to supplement mechanical and chemical weed control.

**Chemical control.** The adaptation of herbicides to sugar beet culture has utilized several application techniques.

**Pre-planting.** On moist soil or on areas which can be irrigated, preplanting applications of from 3 to 6 lb/A of IPC may be used to control wild oats. Applications should be made to non-lumpy soil and thoroughly disked in before planting.

**Pre-emergence.** Annual grasses, except wild oats, may be controlled by TCA at 5 to 7 lb/A applied before emergence of the beets. If it is not possible to spray before emergence of the crop, it is best to wait 10 days and then apply TCA at the above rates. This will be pre-emergence to much of the grass. Some beets will be stunted. This should be considered an emergency treatment.

**Post-emergence.** Dalapon at 2 to 4 lb/A will control most emerged annual grasses. For wild oats a rate of 4 to 6 lb/A is needed. The killing action of dalapon is slow, particularly on wild oats, but treated grasses usually make little or no further growth. Beets may be



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temporarily retarded by dalapon treatments particularly when the higher rates are used.

Selective control of certain annual broadleaf weeds may be obtained by the application of sodium chloride (common salt). From 200 to 300 lb/A in 100 to 200 gal/A of solution, applied when the beets have 2 to 4 true leaves, is required. This treatment is not effective on lambsquarters and purslane.

## WEED CONTROL IN TURF

**W. H. Daniel**

Cultural practices of good turf management, including adequate fertility, adapted grasses for use and climate, and proper management have long been included in the art of turf culture. Today herbicides may, by preventing or removing weeds, reduce competition for best turf performance.

### Post-Emergence Controls

**Dandelion, buckhorn, curled dock and many relatively easy-to-kill broadleaved weeds:** Amine salt, or low volatile ester or 2,4-D at 1 lb/A. Apply any time weeds are actively growing. Fall treatments preferred in cool, humid regions since grasses fill in dead weed space. For small area 1 fl. oz. (of 4 lb/gal conc.) treats 1,000 sq. ft.

**Wild onions, wild garlic, young knotweed, and other hard-to-kill broadleaved weeds:** Repeated sprayings of a low volatile ester, or amine salt of 2,4-D at 1 lb/A, plus a detergent to improve wetting of plant surface preferred. Spray in early spring for knotweed control when plants are young. For onions, spray after emergence in late fall and again in early spring before young side bulbs develop. For spots of hard-to-kill weeds, including wild onions, use 5 ounces 2,4-D in 1 gal water, use rubber glove to protect hand, and mop or dampen leaves with crushing and bruising of the waxy leaf coating. Wax bars, wax or sponge sticks, and wet rollers may reduce drift and application problems with 2,4-D. Juska reports 2 lb/A of 2,3,6-trichlorobenzoic or 4 lb/A polychlorobenzoic specific for red sorrel.

**White clover, other legumes, and other weeds:** Use silvex or 2,4,5-T at 1 to 1.5 lb/A in late fall or spring. To avoid bentgrass injury be sure soil has ample moisture. Endothal, widely tested for clover and chickweed, is not as selective and may cause tip burn of turf leaves.

**Chickweed, henbit and other hard-to-kill winter weeds:** Neburon, 0.5-1.0 lb/A actual, is very specific for comomn and mouse-ear chickweed. Silvex, 2,4-D and 2,4,5-T at 1.5 lb/A may reduce established weeds 80-100%, or kill young weeds. KOCN, sodium arsenite, or foliage burning chemicals may reduce vigor and competition. Arsenic carrying compounds (see pre-emergence on turf) may kill old or new plants of common or hairy chickweed.

**Crabgrasses, witchgrass, barnyardgrass, foxtails, sedges, dallisgrass:**

a. Organic arsenics—amine (octyl dodecyl) methyl arsonate (AMA) and disodium monomethylarsonate (DMA) at 2.1 and 2.8 lb/A respectively of actual arsenic in 2-3 applications, 5-7 days apart (For example, 8 oz/1000 sq ft of 50% hexahydrate) are widely used. These are available as 16-25% liquids, 50-75% soluble powders, and 2-5% diluted dry spreader formulations. AMA works faster and better than DMA in cool weather.
b. PMA at .75 lb/A (5 to 7 pints/A of 10%) is a combined herbicide-fungicide. Three applications, preferably on young crabgrass at 7 day intervals are required. PMA is available as 10% and 33% liquid, and dilute dry spreader applications.
c. KOCN has been largely replaced by organic arsenics. Repeated application of sodium arsenite 1 to 30 lb/A is used on large turf areas for foliar burn of all plants.

**Perennial grasses, such as nimblewill, tall fescue clumps and others:** Dalapon at ¼ lb dissolved in 1 gal water applied to wet individual plants or spots will kill all lawn plants contacted. In warm moist soils replanting may be done in 3-6 weeks.

**Poa annua**—bluegrass turf or mixed turf, 4 lb/A of 18% neburon has removed *Poa annua* in mid-spring treatments. May damage red fescues. See crabgrasses below for arsenic suggestions.

### Pre-Emergence Controls

**Crabgrasses and annual summer grasses.**

a. Recent research on arsenic toxicity at Purdue University and other stations supported by earlier work of Welton of Ohio and others around 1935, plus limited observations of lead arsenate preventing crabgrass, have encouraged industry to prepare granular or pelleted formulations of arsenics for use on turf. Currently, arsenic toxicity required is provided by equivalent of 3-5 lb of metallic arsenic/1,000 sq ft as
   12 lb calcium arsenate either powdery, pelleted or granulated, or
   24 lb lead arsenate, powdery, or
   25 lb 19% water soluble arsenic, plus 8% lead arsenate (PAX).
   These will be available as dry spreader applications in 1959. Arsenic toxicity lasts from 1 to 3 years and would need annual supplement of ⅓-¼ initial rate for maintaining toxicity. Bluegrass and bentgrass are quite tolerant to rootzone arsenic toxicity. The rates above may kill chickweed and prevent new plants. Also, these rates prevent *Poa annua* vigor and survival.
b. After several years of variable results, chlordane toxicity to seedlings immediately after emergence, is being utilized in sales. Rates of 50-100 lb/A active chlordane have been tested. Liquids, wettable powders, granules and vermiculite carriers are offered. Toxicity usually expected for only one season. Much research with both arsenic and chlordane toxicity needs to be done; for example, on goosegrass.
c. Continued tests with NPA, CDAA, 2,4-D, 2,4,5-T, neburon. Falone and other seedling-toxic herbicides, which lose toxicity within 2-4 weeks after application have not resulted in widespread use. The repeated chance of delayed infestation limits their use unless repeatedly applied.

**Seedbed sterilization** with methyl bromide has been very successful, although comparatively slow. Seedbed toxicity with calcium cyanamid has not received wide use, although widely explained. Vapam, Mylone and Cyanamid all have the problem that a few surface seeds escaping may reduce effectiveness.

EPTC, CIPC and monuron have caused stunting of bluegrasses.

## WEED CONTROL IN HORTICULTURAL CROPS

The proper use of herbicides may reduce markedly the cost of weeding in many horticultural crops and will save some crops when wet weather renders cultivation ineffective or impossible. However, chemical weed control should not be considered as a substitute for all cultivation, but rather as a supplement to standard cultural operations.

### VEGETABLES

**R. E. Nylund and S. K. Ries**

Early research with 2,4-D and related compounds indicated that with the exception of sweet corn and asparagus, most vegetables were extremely susceptible to these materials. Early work consisting of screening for post-



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emergence herbicides was unsuccessful, but some of the same materials seemed to have a place as pre-emergence herbicides on certain vegetable species. Erratic results with many pre-emergence herbicides prompted research on the effect of soil moisture, soil type, temperature, and time of application on the effectiveness of specific treatments. This information has led to some very successful practices for many of our vegetable crops.

**Asparagus:** Asparagus has been one of the easiest vegetable crops to control weeds in because it seems to be resistant to many herbicides. 2,4-D, sesone, DNBP, NPA, TCA, dalapon, monuron, diuron and simazin have all been used successfully.

The best proven practice has been the use of monuron at 1 to 3 pounds per acre depending on soil type, applied after disking in the spring and again after the cutting season. Dalapon has been proven superior to TCA for the control of quackgrass in asparagus. The most effective treatment has been 10 to 20 pounds per acre of dalapon applied any time when the quackgrass is at least five inches tall.

Weeds may be controlled in asparagus seedlings with no more than one pound per acre of diuron applied at time of planting or three pounds per acre of DNBP, just before emergence of the asparagus seedlings. Simazin has also shown promise as a pre-emergence chemical for asparagus seedlings.

**Beans:** Pre-emergence sprays have been most successful in beans. Banding the material over the row in combination with cultivation between the rows has proven most practical.

Four to 9 pounds of DNBP per acre of actual sprayed area will control annual weeds. The higher rates should be applied when the materials are applied immediately after planting, and the lower rate at emergence. Treatment at emergence has proven most successful during very dry or cool seasons in Michigan, Wisconsin and Minnesota.

A chemical which has shown promise where smartweed or purslane is a particular problem except in Ohio is CIPC at 4 to 8 lb/A. The higher rate should be applied on dark colored loams or clay soils and the lower rate on light colored or sandy soils.

Other materials which have been tested recently and which look promising on snap beans are EPTC at 2 to 6 lb/A and CDAA at 4 lb/A. The EPTC should be worked into the soil for most effective results.

**Crucifers:** (Cabbage, cauliflower and broccoli.) Where these crops are direct seeded, TCA at 4 to 6 lb/A applied before emergence has controlled annual grasses. Recently there have been several reports of weed control without crop injury from 4 lb/A of CDEC.

**Cucurbits:** The most successful chemical for cucumbers, muskmelons and watermelons has been NPA as a pre-emergence spray of 2 to 3 lb/A on sandy soils, 3 to 4 lb on sandy loams, and 4 to 6 lb on clay or silt loams. Poor weed control has occurred when there has not been surface moisture either at or shortly after application, when the soil is cold, or when weeds have emerged prior to application. This material may be used on these crops as a post-emergence application of 4 lb/A; however, care must be taken that no weeds are present, that there is sufficient moisture and that the temperature is not over 85°F. It has recently been reported that NPA also may be more effective if it is worked lightly into the soil one week before planting.

Too many varieties of pumpkin and squash are susceptible to NPA to recommend it, unless experience has established a tolerance for an individual species.

**Celery:** Stoddard solvent will control weeds in celery seed beds at a rate of 75 to 100 gal/A, but should not be used in this crop after transplanting.

**Sweet Corn:** 2,4-D, DNBP, CDAA, and simazin have all proven excellent herbicides for sweet corn. A low volatile ester of 2,4-D should be applied at 1 to 2 lb/A before emergence or 1 lb at emergence. 2,4-D is likely to cause severe injury to certain early varieties of sweet corn such as North Star. All of these materials may cause injury if applied as pre-emergence sprays on light sandy soils.

Simazin has recently proven to be an excellent herbicide for sweet corn at rates of 2 to 4 pounds per acre applied at time of planting. This will give the most residual weed control of any of the materials discussed.

Post-emergence sprays of 2,4-D at ¼ to ½ lb/A have controlled most broad-leaved weeds without reducing yield. The lower rate is for ester formulations. Stalk abnormalities and lodging occur, but are usually not serious. Spraying should be done when the weeds and corn are small.

**Tomatoes:** To date, there has been no herbicide that could be used consistently without causing injury to transplanted tomatoes. When weeds emerge before the direct seeded tomatoes, Stoddard solvent at 50 gal/A applied at least 1 day before emergence of the tomatoes will give good weed control. Where annual grasses make up most of the weed population, a pre-emergence treatment of TCA at 3 lb/A two days before emergence has given good results. A combination of 3 lb of TCA and 16 lb of potassium cyanate is effective where there is a mixture of grasses and broadleaved weeds. Neburon, CDAA, EPTC and simazin have shown some promise as lay-by sprays, however, injury has also been reported from use of all of these materials.

**Spinach:** CIPC will control many annual grasses, purslane, smartweed, and chickweed. The rates used have been 2 to 3 lb on sandy soils, 3 to 4 lb on heavy mineral soils and 6 to 8 lb on muck. When the temperature is below 60°F., it is best to use the lower rate and when the temperature is above 60°F., the higher rate is most effective. CDEC at 4 lb per acre has also been proven to be a good herbicide for spinach.

**Onions:** Beginning in 1945 with attempts to use 2,4-D, various oils, and DNBP as post-emergence herbicides, a large number of herbicides have been screened for their effectiveness both as pre- and post-emergence herbicides for onions. Most of these tests have been conducted on muck soils inasmuch as most onions in the North Central region are grown on this soil type. In addition to numerous trials to determine the tolerance of weeds and onions to various kinds and dosages of herbicides, tests have been conducted to determine the relation of time of spraying (relative to seeding date) to herbicide effectiveness and crop tolerance, the relation of stage of onion plant development to tolerance to certain herbicides, and the relation of environmental factors such as temperature, rainfall, and soil type to weed control and crop injury. In more recent studies, the possibilities of using combinations of herbicides to control a wider spectrum of weed species, the economics of chemical versus cultural weed control, and the use of granular herbicides have been investigated.

*Pre-emergence applications:* Under conditions where weeds emerge before the onions, contact herbicides such as 3 to 5 percent sulphuric acid at 100 gal/A, Stoddard solvent at 60 to 80 gal/A, and 75 to 100 lb calcium cyanamid dust give effective control of small annual weeds. The latter herbicide must be applied when weeds are wet with dew. Pre-emergence herbicides which give residual weed control and thus may be applied even before weeds emerge include: (1) CIPC at 4 to 6 lb/A on mineral soils and 8 lb on mucks, (2) CDAA at 4 lb on mineral soils and 6 lb on mucks, (3) diuron at 1.5 to 2 lb on well-drained muck, and (4) a combination of 4 lb of CIPC and 50 gal Stoddard solvent. CIPC is particularly effective on smartweeds and purslane. CDAA gives good control of grasses but variable control of annual broadleaved weeds. In recent trials, a CDAA-related herbicide — alpha-chloro-*N*-ethyl-*N*-phenylacetamide—has given excellent weed control without crop injury when applied at 6 to 8 lb on muck soils.

*Post-emergence applications:* For the control of weeds in onions in the "loop" stage or the late 1-leaf stage, post-emergence sprays of 6 to 8 lb/A of CIPC or 12 to 16 lb/A of potassium cyanate have been effective on muck soils. In recent trials, monuron at 1.6 lb/A alone or at 0.8 lb in mixtures with either 2 lb CDAA or



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4 lb CIPC have given good weed control without crop injury in muck soils.

For the control of weeds in onions having three or more leaves, basal applications of 3 or 4 percent sulphuric acid at 100 gal/A( 16 to 20 lb of potassium cyanate, 8 lb of CIPC, 4 to 6 lb of CDAA, and 5 to 10 lb of EXD (Herbisan 5) in 50 to 100 gal/A of water have been effective. On muck soils basal applications of 1.5 to 2 lb/A of monuron have also given good residual weed control without crop injury, as have mixtures containing 0.8 lb monuron and 4 lb CIPC or 4 lb CDAA.

In onion fields that are weedy at harvest, the use of DNBP has effectively eliminated such weeds and made it easier to use mechanical harvesters.

*Cultural control:* Because of their slow early growth and limited foliage, onions are extremely poor competitors of weeds. Early weed removal is necessary to avoid yield reductions. Attempts to devise mechanical methods of removing weeds in the row have, in general, been unsuccessful. The use of herbicides to eliminate most of the spring flush of annual weeds has made it possible to reduce the labor requirements for the first and second hand weedings. However, some hand weeding is usually required as none of the herbicides developed to the present time have given complete control of the many species of weeds which may be present in onion fields. Even well-established onion plants compete poorly with weeds so that the use of rotary tillers and other methods of cultivation do not eliminate the necessity for hand weeding even late in the season. Weed growth in onions which have been laid-by interferes with the use of harvesting machinery. Thus, lay-by applications of herbicides having lasting residual effects are necessary to keep onion fields weed-free to harvest. To the present, no mechanical methods of eliminating the weed problem in onions have been developed to replace handweeding and the use of herbicides.

**Potatoes:** Early work showed potatoes to be quite tolerant of 2,4-D and other herbicides applied prior to crop plant emergence. Herbicides applied post-emergence, however, have usually caused some injury although, because of the vigorous growth of potato plants, this injury has not always resulted in reduced crop yields. Weed control research with potatoes has been largely confined to the screening of herbicides for use in this crop. As a result of this screening, at least one incidental effect of herbicides on potatoes was observed and has become important in commercial practice. This is the use of 2,4-D as a post-blossoming vine spray to intensify the periderm color of red-peridermed varieties of potatoes.

*Pre-emergence applications:* A number of herbicides have given effective residual control of weeds when applied pre-emergence. These include 5 to 10 lb/A of DNBP, 2 to 4 lb of 2,4-D, and 4 to 6 lb of CDAA. Monuron at 2 lb/A has also been effective on muck soils but has caused injury when used on mineral soils. Where annual grasses are a problem, TCA at 8 to 10 lb/A has given good control when used alone as a pre-emergence spray or when used in combination with one of the above herbicides.

Where quackgrass is a problem, either fall applications of TCA or dalapon or spring pre-planting applications of dalapon have given effective control of this weed. Dalapon must not be used as a spring application on land to be planted to red-skinned varieties of potatoes, as the treatment has caused the loss of red pigmentation from the tuber periderm of such varieties.

*Post-emergence applications:* Post-emergence applications of herbicides to potatoes have usually reduced yields and thus are not recommended. However, under extremely wet conditions which preclude the use of mechanical cultivators, aerial applications of ½ to 1 pound per acre of 2,4-D have been used successfully as a post-emergence spray to control such weeds as perennial sowthistle but not without some reduction in yield.

*Cultural control:* Interest in the use of herbicides in potatoes has been limited by their high cost relative to mechanical cultivation which usually consists of pre-emergence harrowing followed by two or more cultivations and a hilling operation. Recently, however, concern over crop damage and damage to soil structure incurred by the use of heavy machinery in potato fields has resulted in considerable interest in the use of herbicides and in alternative methods of potato culture such as multiple-row planting which would minimize this damage.

**Root Crops:** The only root vegetables which have received much attention in weed control research are red beets, carrots and parsnips. As with potatoes, weed research in these crops has been largely confined to the determination of kinds and dosages of herbicides which could be used effectively for pre- and/or post-emergence weed control. However, one study on competition effects of weeds on carrots and beets showed that these crops are seriously damaged by very low populations of weeds when the latter are allowed to remain in the row for a short period after emergence.

*Pre-emergence applications:* For beets, the only herbicide which has given weed control without crop injury is TCA at 8 to 10 lb/A. This herbicide has controlled annual grasses quite well on mineral soils but, in general, has been less effective on muck soils.

For carrots and parsnips, the use of Stoddard solvent at 80 to 100 gal/A has been so outstandingly successful as to become the standard method of controlling weeds in these crops.

*Post-emergence applications:* For beets, if weather conditions have prevented spraying with TCA before crop emergence, this herbicide has been successfully applied post-emergence as an emergency measure to control small annual grasses but not without some stunting of the beets. When used post-emergence, TCA should be applied about 10 days after beet emergence.

In carrots and parsnips, Stoddard solvent will selectively kill most small annual weeds without crop injury. Rates can be reduced by early evening applications when the air is still and humidity is high. To avoid off-flavors, carrots should not be sprayed after the tap root is more than ¼ inch in diameter. To avoid crop injury, parsnips should not be sprayed after five or more leaves are present.

*Cultural control:* By the proper use of Stoddard solvent, carrots can be grown to maturity without handweeding and without cultivation. The parsnip must be cultivated and/or handweeded during its later stages of growth. Since no entirely effective herbicide has been found for use in beets, this crop still requires handweeding and/or cultivation. Likewise, since beet seed is multiple-embryoed, thinning of the crop plants is necessary. The use of sheared seed together with an effective selective herbicide for this crop could effect large savings in production costs.

## FLOWERS

**J. P. Mahlstede**

The history of weed control in flowers dates back into antiquity; the use of herbicides in flowers is a recent development. Of the vast array of ornamental flower crops only four, namely, daffodil, gladiolus, peony and chrysanthemum have received extensive consideration from state and federal weed control researchers. This fact would lead to the conclusion that either weed conclusion that either weed control is not a problem in floricultural crops, or that control of weeds in flowers by means of chemicals is particularly complex and difficult. Both conclusions are to some extent true.

The planting of annual flowers in outdoor beds generally makes use of plant materials which have either been grown in pots or which have some growing medium surrounding the roots. Under normal growing conditions these plants establish themselves and grow rapidly, eliminating serious weed competition through



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shading and competition for moisture. Under these conditions only a few initial hand and subsequent spot weedings are necessary in beds of this type. Soil sterilization and fumigation by the use of steam, granular calcium cyanamid, methyl bromide, DMTT, SMDC and chloropicrin have been used as preplanting treatments for flower beds. As might be expected, because of the wide variety of annual and perennial flowers, there is considerable variability in tolerance of any one family, genus, species or horticultural variety to a specific chemical. For example, Blue Perfection ageratum, Powder Puff aster, Five King and dwarf nemesia, lilies, and marigold were not damaged by neburon at the rate of 5 lb/ A. White carpet alyssum and Mixed Globe phlox, however, were severely injured by comparable rates of this chemical. Swiss Giant pansy and salpiglossis were stunted, and foliage chlorosis was evident on Double Giant zinnias. Potted plants of Shasta daisy and anemone, which were allowed to become established for two weeks in outdoor beds before herbicide application showed no signs of injury from the application of sesone at 4 lb/A, NPA-20G 5 lb/A, or simazin 2 lb/A. Similar results have been reported in planting of potted *Impatiens balsamina, Mathiola incana, Calendula officinalis,* and *Tagetes patula* which had been allowed to become established for one week before treatment with sesone at the rate of 4 lb/A.

Outdoor producers of wholesale cut flowers as well as nurserymen and plant breeders raising large quantities of bulbs, corms, and root crops were among the first to become interested in and to use chemicals for the control of annual and perennial weeds. The pre-emergence application of 2,4-D at rates of 2 to 4 lb/A in plantings of gladiolus, Dutch iris, and daffodil generally has resulted in the satisfactory control of germinating weeds. Timing, in relation to the development of the flower and weed crop, as well as the temperature and rainfall during and following herbicide application has resulted in weed control which was quite variable from season to season and from year to year. Later studies with field grown daffodils have indicated that a medium fall application of 2,4-D (5 lb/A), followed by a light (2 lb/A), post-flower treatment might have the greatest advantage for controlling weeds in this crop. Even though the use of 2,4-D on established, foliated daffodils appears to have merit, it is not generally recommended because of the need for further investigation.

In iris, narcissus and tulip farms, broad-leaved weeds such as chickweed, shepherd's purse, and species of mustard, as well as annual grasses can be controlled by a mixture of DNBP, 6 qt/A and CIPC, 1 gal/A, applied before shoot growth breaks through the soil. A sequence for an effective summer weed control program in these crops has not been developed as yet. Monuron has given good weed control in iris plantings, but when applied as a post-emergence treatment in tulips and narcissus fields, it has caused some injury. Diuron 4 lb/A, simazin 4 lb/A, and CIPC 3 to 4 lb/A, applied in the fall, merit further testing.

For the control of most annual broad-leaved weeds in gladiolus, pre-emergence treatments of 2,4-D (ester or salt) at 2 lb/A (referring to the actual area sprayed), DNPB at 8 lb/, and sesone at 3 to 6 lb/A will generally give satisfactory results. Where annual grasses are the primary problem, TCA at 10 lb/A can be used on the larger corms as a pre-emergence spray. If both types of weeds are present, a mixture of 1 pound of 2,4-D and 10 lb of TCA may be used. Post-emergence treatments with 2,4-D (salt) at the rate of 1 lb/A, when the gladioli are six inches tall or before the blades open, generally controls most weed types in the row. Considerable injury has been noted when higher concentrations of 2,4-D were used, or if the crop was treated in the later stages of growth. The use of sesone as a pre- or post-emergence application at the rate of 3 to 4 lb/A has been less injurious than 2,4-D. Although cormels grown for size increase are more subject to injury than flowering sized corms, sesone has been applied successfully at the rate of 3 to 4 lb/A before, or immediately after the leaf blades appear.

Weeds in peony plantings may be controlled by pre-emergence treatments of Stoddard Solvent, 80 gallons per acre fortified with 8 lb of PCP. This mixture generally controls weeds present in plantings at the time of application. Any residual chemical would undoubtedly be harmful to the developing peony shoots, which emerge quite early in the growing season. The ammonium salt of DNBP (5 lb/A) and the sodium salt of 2,4-D (1 lb/A) applied before emergence of peony shoots has given relatively good weed control.

In chrysanthemum transplants, directed basal sprays of monuron at 1 lb/A, monuron plus sesone at 3 to 4 lb/A, or a combination of CIPC at 4 lb/A and TCA at 6 lb/A have been used quite successfully to control a complex of generally occurring garden weeds. Sesone at the rate of 3 to 4 lb/A can also be applied to weed free plots containing established, transplanted chrysanthemums.

## FRUITS

**D. D. Hemphill**

**Apple orchards:** Apple trees are grown normally under sod culture with Kentucky bluegrass the dominant grass species. To encourage vigorous tree growth in the newly planted orchard competition from the grass and weeds is reduced by the cultivation of an area around each tree. After the tree begins to bear this practice is discontinued and weed control is accomplished by mowing; however, a number of plant species thrive beneath the limb spread of the mature tree where mowing is difficult. These plants compete with the tree for nutrients and water, create nuisances and health hazards for the pickers and provide cover for trunk and/or root girdling mice.

*Newly planted trees:* Cultivation around the young tree has been accomplished by hand labor and various types of tillage implements. Today specially designed tree cultivators which do a thorough and economic job are available to the orchardist. For several years herbicides have been tested for use around young trees to eliminate or supplement cultivation. Where erosion is a serious problem cultivation is undesirable and a combination of a mulch and a herbicide is very desirable. Some of the more promising herbicides are diuron 2 to 4 lb/A, CIPC 10 lb/A and simazin 4 lb/A.

*Bearing orchards:* Research in the use of herbicides in the bearing orchard has been primarily for the control of weeds beneath the limb spread. It was found that 2,4-D could be used safely and repeated applications of this chemical at 1½ lb/A or a wetting spray at 1500 ppm (.15%) has given control of poison ivy and many annual and perennial broadleaved weeds. Brambles, elm, oak, hickory and many other woody species were resistant to 2,4-D, but have been controlled effectively by 2,4,5-T or mixtures of 2,4-D and 2,4,5-T. Only amine salt or low volatile ester formulations of 2,4-D and 2,4,5-T should be used.

Ammonium sulfamate (Ammate) has been found effective on poison ivy and somewhat effective on perennial weeds and grasses when applied as a wetting spray using 1 to 1½ lb. per gallon of water. Wetting agents are reported to improve coverage and kill. Ammate is non-volatile but highly corrosive.

Dalapon has given effective control of grass beneath bearing trees when used at 10-15 lb./A. Trees under four years appear susceptible to injury by this treatment.

For the control of all vegetation beneath the bearing tree amitrol 4 to 8 lb./A and diuron 20 lb./A have shown considerable promise. Amitrol has been particularly effective on horse nettle and poison ivy.



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Apple trees appear extremely sensitive to polychlorobenzoic acids. These chemicals applied in August for the control of weeds beneath the limb spread have caused severe foliage distortion the following spring.

**Peach orchards:** Most peach orchards are grown under a system of clean culture with a winter cover crop; however, there is a trend toward sod culture with hand or machine cultivation around individual trees. Several herbicides have been tested for use around young and bearing trees but peach trees appear very sensitive to present herbicides and none are considered safe to use at the present time.

**Brambles**: Weeds within the plant row of brambles grown in a hedge row or linear system cannot be controlled satisfactorily by machine cultivation. Deep mulches of sawdust, shavings, ground corn cobs or straw help measurably in the control of these weeds, but the cost may be prohibitive. New types of mechanical hoes have been developed but none can remove weeds within the bramble row. To find more satisfactory methods of weed control several herbicides have been tested and many have been found useful for controlling a specific weed or for application at a given season or stage of growth.

*Chemical controls:* These crops were found to be somewhat tolerant of 2,4-D. Basal directed sprays control many species of weeds and result in a minimum of injury to the canes. The first application should be made early in the spring before weeds and new shoots emerge. Repeat applications should be delayed until the new bramble shoots are tall enough to permit spraying without hitting the tips. Rates of ¾ to 1½ lb/A are used with lower rates for ester formulations and higher rates for amine salt formulations.

Basal directed sprays of DNBP (amine), 3 to 4 lb/A, applied in early spring before new bramble shoots emerge and again after the shoots are about two feet tall have proven beneficial.

Sesone at rates of 3 to 6 lb/A has been found safe for use at any season or stage of growth. Early spring applications, especially in the northern states, are not as effective as desired, due possibly to the slow conversion of the chemical to the active form.

Fall-germinating grasses and common chickweed have been suppressed by October and November applications of CIPC, 6 lb/A. Dalapon has appeared promising as a fall spray, also.

Diuron and simazin are being tested presently. Chemicals with relatively long residual properties are highly desirable in this crop.

**Grapes:** Weed control research in grape vineyards has been concerned primarily with the control of weeds beneath the grape trellis. Vineyards are cultivated during the spring and summer and weeds between the rows are controlled readily by a disk or a cultivator but special equipment is required to remove weeds beneath the trellis. Research in this field has been toward the development of more satisfactory mechanical hoes as well as the testing of herbicidal chemicals and the development of sprayers to apply them. Immediately grapes were found to be extremely sensitive to 2,4-D and related herbicidal chemicals.

*Cultural control:* During the past ten years several mechanical hoes have been developed which are from an engineering standpoint a marked improvement on the initial grape hoe which consisted of a small blade that was moved manually in and out between the vines and posts within the row. Recent models of the grape hoe are hydraulically operated and many cultivate by a rotary action. Injury to the trunk and roots of the vine still occurs, nevertheless, and operation in terraced vineyards is extremely difficult.

*Chemical controls:* An important advance was made when research developed an effective herbicidal spray consisting of an oil emulsion fortified with DNBP or PCP. This is an effective contact herbicide for young annual weeds but has limited residual properties and two or more applications each season may be necessary. Injury to young vines is another limitation of this treatment. Studies were continued in an effort to find a safe herbicide with long residual properties.

CIPC 10 to 14 lb/A, was found to be relatively safe and gave satisfactory weed control where annual grassy weeds were the primary problem. Monuron was tested soon after it was made available to research workers. It performed very satisfactorily in mature vineyards but caused severe chlorosis and even killed young vines. Diuron, being less soluble, was substituted for monuron and this chemical is presently recommended in several states at rates of 2 to 4 lb/A. Simazin has been tested rather extensively during the past three seasons and has performed very satisfactorily.

Weed-spray booms have been designed specifically for use in the vineyard; however, this operation can be accomplished with less elaborate equipment. A simple boom with end-mounted off-center weed nozzles permits the spraying of two rows simultaneously.

**Strawberries:** Weed control in strawberries is a tedious and expensive operation. Costs have been more than $100.00 per acre during years of abundant rainfall and in some instances new fields have been abandoned due to inability to control weeds. Labor costs have been high due to the necessity of using hand labor to remove weeds within the plant row.

The discovery in 1946 that strawberries were somewhat resistant to 2,4-D was received with enthusiasm by everyone concerned with the production of strawberries and has stimulated continued research in the use of herbicides in strawberries.

Research in the design of machinery has been fruitful also and mechanical hoes well suited for use in strawberries and other transplanted crops are now available.

*Cultural control:* In most seasons weeds in newly set fields can be controlled very satisfactorily by mechanical cultivation or hoeing until runner plants begin to establish roots. After this time weeds within the matted row are difficult to control and mechanical hoes, although beneficial, are not entirely satisfactory.

*Chemical control:* Early research with 2,4-D showed that established plants would tolerate concentrations that would kill many young vigorously growing broadleaved weeds. After this information was known 2,4-D was tested rather extensively for the control of weeds in newly set fields.

Application of 2,4-D before the plant was well established resulted in considerable injury. To obviate this injury pre-planting treatments were made and were found to be promising. Two to three pounds of 2,4-D gave residual weed control for 3 to 4 weeks while the plants were becoming established.

Further research showed the 2,4-D (amine), 1 lb/A could be used as a selective foliage spray during the period from 3 to 4 weeks after setting until late August when fruit bud differentiation begins. Treatment at time of runner initiation however, usually caused a marked inhibition of runners. Application during fruit bud differentiation resulted in marked distortion of fruits, leaves and stolons. Application in late fall, after fruit bud differentiation, for the control of winter annual broadleaved weeds has been very beneficial in some states. 2,4-D (amine) has been found to have an important place in weed control the second summer. An application of 1½ lb/A immediately after harvest and a second application approximately one month later reduces weeds markedly.

Sesone was found to be very useful in new plantings. It can be applied immediately after setting at rates of 2 to 4 lb/A and repeat applications can be made during the spring, summer and fall months as needed. Due to the nature of the chemical it is safer than 2,4-D, however, in some cases, reduction in runner production has been reported. Sesone is effective against most weeds but its action is that of a seed toxicant and consequently must be applied to weed free soil. Under conditions of



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slow conversion to the active form weed control has been ineffective.

Fall germinating grasses, common chickweed, and henbit quite often become serious problems. CIPC was found to give very effective control of these weeds but injury to the strawberries has been reported. Use of granular CIPC or delaying the application of the liquid CIPC until the plants are dormant appears safer.

DNBP (amine) has also been used to kill fall germinating weeds. Considerable injury has resulted, however, if the strawberry plants were not fully dormant at time of application. Rates higher than 3 lb/A are likely to give injury.

In areas where quackgrass is a problem, a fall preplanting treatment with dalapon, 10 to 15 lb/A, followed in 10 to 14 days by plowing has shown promise.

Mulching materials have been found to inhibit weed germination and should not be removed from the plant row unnecessarily. Some mulching materials can be a troublesome source of weed seeds, however, and should be selected with care.

Grasses, especially crabgrasses, that germinate during the fruiting period (bloom to harvest) create a serious weed problem. Research has not, as yet, provided a satisfactory solution to this problem. Most promising results, to date, have been with granular forms of herbicides applied just before crabgrass germination.

## WEED CONTROL IN ORNAMENTAL AND FOREST NURSERIES

**L. G. Holm**

Chemical weed control in ornamental and forest nurseries poses several unique problems. Weed control in nursery crops is complicated not only by the diversity and number of plant genera, species, and cultivars, but also by the variation in the age of plants at the time of treatment. Thus, it is necessary to define precisely the conditions of chemical and cultural weed control.

Many woody species, especially the deciduous plants, many suffer severely in competition with weeds for light, nutrients, and moisture. Hand weedings are slow and very expensive; their effects may be of short duration; and their frequency depends upon weather conditions and season.

The fact that slow-growing nursery stocks may remain in the same beds for sveral years enables annual weeds to multiply by repeated seedings and perennial weeds to invade the area and to become established.

Certain precautions must be taken. Nurseries frequently are located on light, sandy soils. In such situations, not only is the margin of safety low for the use of chemical herbicides, but also the danger exists of toxic residues from repeated applications. Generally, the same land is used over and over with a minimum of crop rotation. Hence, every effort should be made to maintain the most favorable growing conditions.

Although nursery weed control must be approached cautiously and with an understanding of the complicating factors, there is much to favor the use of chemicals in nursery plantings. The high crop value makes it economically feasible to use chemicals for weeding. The limited areas permit intensive management under the most favorable, controlled conditions. Very specialized and even complicated treatments where timing is critical are possible with one or several chemicals, alone or in mixtures. Where available, overhead irrigation systems provide a ready means of application for some chemicals as well as effective moisture control.

Chemical weed control in nurseries has received comparatively little attention. Since 1945, only a few investigators have devoted a portion of their time to this subject. For the most part, the work has been a retesting of treatments developed for other crops. Commercial operators have been reluctant to jeopardize established, high valued stock for the testing of "unknown" chemicals. Preliminary screening, therefore, has been left to experiment station researchers and to certain forest nurseries to establish data relative to tolerance, timing, and rates of application. The majority of the work before 1950 was concerned with the use of steam and poisonous gases for the fumigation of seedbeds, and of certain petroleum oils for weed control among coniferous seedlings. For example, Stoddard solvent has given effective control of several annual weeds when applied at the rate of 25 to 50 gallons per acre either before or after coniferous seedling emergence. Since then, limited information has accumulated regarding newer organic chemicals.

**Seedbeds:** For many years steam sterilization and the use of methyl bromide and chloropicrin were suggested as preplanting treatments of seedbeds. In 1955, the successful use of "drench" fumigants such as SMDC (Vapam) and DMTT (Mylone) in other crops prompted their trial also in nursery seedbeds. Favorable initial results have continued their further use and stimulated research on other fumigants. Cost and ease of application were major considerations in their use.

**Transplant beds:** Moving seedlings within the nursery allows two types of chemical treatments: preplanting and postplanting. The latter may be directed toward the base of the plants or simply sprayed over their tops. The lack of satisfactory equipment for applying directed sprays has limited their use.

Organic chemicals were tested first in 1950 for nursery weed control in this region. For example, TCA was used as a preplanting soil treatment for the control of perennial grasses. Frequently, the treatment was made in the season preceding the transplanting. On occasion, high rates were used in "spot" application. Subsequently, dalapon and maleic hydrazide also proved effective for grass control. Similarly, 2,4-D provided control of broad-leaved weeds and with 2,4,5-T, eliminated brush on planting sites.

Perhaps the most commonly used organic herbicide in nurseries was sesone. Its use as a postplanting, overall spray was reported in 1951. Its effects have been tested on many species and varieties including both coniferous and deciduous plants. Few have been injured. A favorable attribute of sesone was that it did not injure the above-ground portion of the plant on contact. Thus, it was applied with safety. Its shortcomings were; it had a short residual period, it had to be applied to weed-free areas, and it was ineffective against grasses. Results of studies since 1953 were significant. Monuron and diuron at ¼ to 1 lb/A in combination with sesone at 4 lb/A have provided control of annual weeds for many weeks. Somewhat higher rates have been tested on heavy soil types. Dalapon at 5 lb/A, in combination with the urea herbicides, afforded improved control of grasses. Treatment with diuron, dalapon, CDAA, or simazin alone and in combination effectively controlled certain weed species. An increased rate of chemical usually was required when the chemicals were used alone.

The chemical control of established perennial weeds growing in transplant beds has not been explored.

Recently, the reduction or elimination of weed and grass competition has been investigated in young forest plantations. Monuron, diuron, dalapon, TCA, CIPC, simazin and 2,4-D, alone and in mixtures, have been tested with promising results. Preplanting, planting, and postplanting treatments have been tested under different conditions for the preparation and maintenance of planting sites.

**Established nursery stocks:** In ornamental nurseries, plants may remain in the same location for several growing seasons. For example, plants which are maintained to furnish cuttings, scion wood, or budding materials, as well as apple stool blocks, may be 20 or more years old. Other stocks, such as *Taxus* spp., are held



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in large acreages for several years to increase in size. These established plants, with their deeper root systems, may offer greater opportunity for successful use of chemical herbicides. Monuron, diuron, CIPC, TCA, dalapon, and simazin, all of which have some residual effect in the soil, have been reported favorably in tests on some deciduous and coniferous materials. In current studies, CDAA and sesone, alone and in combinations, gave good weed control of weeds in potted shrubs for 3 to 4 weeks with little or no injury to the ornamentals.

To date, however, researchers have not classified the many chemicals as to their effects on even the major plant groups. The great potential of modern methods of chemical weed control in nurseries awaits both intensive basic research and continued field testing.

## WEED CONTROL IN FOREST AND SHELTERBELT PLANTINGS

**Henry L. Hansen**

The considerable diversity of problems involved and of objectives desired is evident from the following outline:

1. **Plantation release**. In this situation plantations of desirable species, frequently conifers, are in need of release from competing species, usually broadleaved hardwoods and brush.

2. **Inducing natural regeneration.** The need for regenerating forest stands often poses serious difficulties in obtaining the species desired, which are usually conifers. Measures are frequently needed to reduce the density of the undercover herbs and shrubs to permit enough light for the successful germination and establishment of the conifer seedlings.

3. **Stand improvement.** During the portion of the life cycle of the forest stand following its establishment and up to early maturity there is often need for regulating its composition to eliminate undesirable species or individuals of poor form. These are usually trees of seedling or sapling sizes.

4. **Pre-planting site preparation.** In forest-type plantings the most serious competing vegetation may include both herbs and shrubs. Sometimes quackgrass as well as rank growths of broadleaved weeds present a serious threat to young planted trees. Most frequently shrubs constitute the problem vegetation. Before planting is begun, it is essential to take whatever control steps are needed.

5. **Forest game management**. One of the mutiple-use objectives in forestry relates to the improvement of cover conditions for forest game such as deer, grouse, and various other species. The selective manipulation of stand composition and cover conditions to favor such species is being recognized as an important forest management objective.

6. **Poisonous plant and alternate host eradication.** Such species as poison ivy are often found on recreational areas and present serious control problems. Considerable effort is also devoted to the eradication or control of various species of *Ribes* which harbor alternating generations of the white pine blister rust.

7. **Weed and brush control on tree plantings on the farm.** Farmstead shelterbelts and field windbreaks present special problems of weed control. A multiple row belt of tree plantings frequently contains a variety of tree species both hardwoods and conifers. This makes for difficulty in finding an herbicide with selectivity to match the variety of tree species present. Mechanical weed control becomes almost impossible when the trees are several years old as they soon become too large to permit the use of tractor drawn equipment, especially near the tree rows. Hand hoeing or herbicidal applications are almost a necessity if the tree belt is to be kept in good vigor and free of various weeds.

Superimposed upon the control difficulties presented by the great variety of vegetation and the various objectives of forest management is the added restriction of economics. Most forest areas are capable of producing only small returns per acre which permit the expenditure of only very limited amounts for management activities. Costs for any type of brush control which exceed more than a few dollars per acre are usually prohibitive except on certain high intensity management areas . On recereational areas, farm windbreaks and shelterbelts, and Christmas tree plantations the economic limitations are nearly similar to those encountered in the production of agricultural crops.

In addition, forestry operations are usually extensive, covering large areas frequently inaccessible by roads or trains, and often on rugged terrain. These conditions usually do not permit the use of either hand equipment or power drawn sprayers and favor aerial applications.

**Control measures:**

**Mechanical.** Hand tools including axes, saws, brush hooks, mattocks and similar equipment have been used for many years. However, the costs per acre for this type of control activity are usually far too great to be practical except on farm and Christmas tree plantings and where aesthetic values are great. Some use has been made especially in pre-planting site preparation of special heavy plows, disks, brush rakes and similar equipment which can be power drawn by heavy plows, disks, brush rakes and similar equipment which can be power drawn by heavy tractors.

**Fire.** Controlled burning has been used with considerable sucess under certain conditions in the South for the prevention of growths of undesired shrubby ground cover and for the encouragement of natural regeneration of pine. Research is underway to test the use of fire in other sections of the country both for forestry and wildlife management purposes.

**Herbicides**. Before World War II little use was made of chemicals in brush control in forestry. Some limited use was made of arsenicals, salt, and sulphuric acid in poisoning unwanted trees, in experiments with *Ribes* eradication, and in the control of herbaceous vegetation on firelanes and in nurseries. The advent of 2,4-D made possible the use of selective treatments which would kill many undesirable broadleaved trees and shrubs without serious injury to the conifers. The ester formulations have been most widely used and most generally successful. The generally greater effectiveness of 2,4,5-T, particularly on various species of *Rubus*, has favored its use in more recent years. Mixtures of 2,4-D and 2,4,5-T, 2,4,5-TP, ammonium sulfamate, amitrol, monuron, and diuron have also been used.

A variety of application techniques have been developed for use on woody plants. These include foliage sprays, basal sprays, stump treatments, frills, girdles, and cups. About 1950, aerial applications were tested and have since offered the greatest practical utility except for farm protection plantings, Christmas tree plantations, and other intensive-use areas where the cost of ground equipment methods may be justified. From 1 to 3 pounds per acre of 2,4-D, 2,4,5-T, 2,4,5-TP, alone or in mixture, applied in 2 to 5 gallons of oil or oil-water emulsions, have been most widely used.

Non-selective herbicides such as monuron and diuron have been used with some success in preparing sites for planting, in encouraging the regeneration of conifers by killing ground cover vegetation and for weed and grass control in tree plantings using rates of up to 10 pounds per acre. Amitrol and dalapon have also been used increasingly for the control of herbaceous competition to planted trees. Ammonium sulfamate has been applied in frills, cups, and girdles to kill rough hardwoods overtopping conifers or other more desirable species.

For eradication of poison ivy the original use of 2,4-D was superceded by the more effective 2,4,5-T. In the last few years amitrol has been found to be superior for control of this pest species.



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## CONTROL OF WOODY PLANTS

## CONTROL OF BRUSH ON RANGELAND AND PASTURES

**H. M. Elwell**

Research to determine the value of chemical treatments, mechancal means, browsing and fire for brush control has been conducted by state and federal investigators for the past several years in the North Central region.

Most of the woody species found in range and pasture land sprout freely when their above ground parts are cut or severely injured by other means. Researchers have tried to develop methods that suppressed both top growth and roots of woody plants.

Since control of regrowth is a major problem in brush suppression, considerable investigations have been made with chemicals and oils for killing woody plants. The methods found to be satisfactory for application of herbicides are foliage sprays, basal bark or cut surface treatments on stumps, in frills, or in cups, or in injections and soil applications.

**2,4-D, 2,4,5-T, or silvex:** These herbicides, formulated as low volatile esters, have given satisfactory control of many brush and tree species on land suitable for range and pasture development. However, their use was most successful when accompanied by a management program which favored prompt recovery of the desirable grasses and native legumes to aid sprout control.

**Ammonium sulfamate:** This chemical has been effectively used for control of most brush species. It has given good results on many woody plants not affected by 2,4-D, 2,4,5-T, or silvex.

**Substituted ureas, fenuron and monuron:** These two materials, both in 80% wettable powder and 25% pellets, have produced good kills of many brush and unwanted tree species. They are most effective as soil treatments These chemicals appear to be absorbed quite readily by the root systems of most woody species. Fenuron and monuron were most effective on sandy soils.

**Foliage sprays, ground equipment:** Woody plants sensitive to either 2,4-D, 2,4,5-T or silvex ester formulations have been satisfactorily controlled with a solution consisting of 1 to 3 pounds of the chemical in 100 gallons of water, applied as a wetting spray on each individual plant. On low brush where boom sprayers may be used, the same herbicide at 1 to 3 pounds per acre in sufficient volume of spray for overall coverage of foliage gave good control.

Ammonium sulfamate in a concentration of a least ¾ lb. in 1 gallon of water with the addition of a spreader-sticker as a wetting foliage spray has been effective on most mixed brush.

The best time to apply foliage sprays on most woody plants was at full leaf development stage and during the three to four week period thereafter, providing soil moisture conditions were sufficient for active growth prior to time of spraying.

**Foliage sprays, aerial equipment:** The post oak, blackjack and associated osage orange, elms, scrub hickory, dokwood, locust, willow brush, and small trees have been successfully controlled with annual applications of herbicides for two conscutive years. In some instances, an application the third year has been desirable. Where either the 2,4,5-T or silvex formulation was used, an initial application at the rate of 2 lb/A was generally necessary followed by retreatments of 1 to 2 lb. Either herbicide was satisfactorily applied in a spray solution at 4 to 5 gal/A. This spray consists of the chemical mixed with sufficient diesel oil to make 1 gallon and emulsified in 3 or 4 gallons of water, or the chemical mixed with the oil alone in an amount necessary to make 4 or 5 gallons. The larger volume of spray was often necessary in treating dense stands of brush. For aerial spraying, oil-in-water emulsions in proportions such as 1:4 give larger droplet size than commonly used oils and thus aid in drift control. Where an equal mixture of 2,4-D and 2,4,5-T was used, the first application with 3 lb and the following treatments with 2 lb in the same quantity of spray solution per acre as for the 2,4,5-T produced effective control. On areas where post oak predominates, the silvex at 1¼ lb/A followed with a second application of ¾ lb/A has produced satisfactory control. The same volume of spray was required as given above.

Shinnery oak control has been obtained with 2,4,5-T low volatile ester at 1 lb in 3 to 5 gal of diesel oil or in an emulsion of 1 gal of diesel oil and 2 to 4 gal/A of water. Early spring foliage applications made for 3 consecutive years have been required for effective control.

Sand sage has been controlled with single application of 1 pound of 2,4-D ester in 3 gallons of an oil-in-water emulsion or 3 gal/A of diesel oil. The best period for spraying sand sage was during May or early June, when the plants had 6 to 8 inches of new growth and were developing rapidly.

Buckbrush, sumac and skunk brush generally have been controlled by repeated early spring foliage application of 1 to 2 lb of 2,4-D ester per acre. The herbicide was best applied in 3 gallons of an oil-in-water emulsion or the same quantity of diesel oil per acre. These plants were also effectively treated with ground equipment, using 2 pounds of the chemical in 10 to 20 gallons of water as a wetting spray. The effectiveness of control varies with different species, variety, location, and time of treatment.

Persimmon is easily defoliated with aerial application of 2,4,5-T. The 2,4,5-T ester (a low volatile formulation generally used) at ½ to 1 lb of acid in emulsion of 3 to 5 gallons total spray per acre has controlled these plants However, two to three annual retreatments were often required to effectively suppress persimmon. For treatment with ground sprayers, the highest rate of 2,4,5-T was necessary in 100 gallons of water to obtain good control. 2,3,6-Trichlorobenzoic acid at 4 lb in 100 gallons of water used as a foliage spray has shown promise for the control of persimmon.

Wild rose, wild blackberries and other brambles have been satisfactorily suppressed with 2,4,5-T ester. They respond to foliage treatment at rates of one to two pounds per acre in the same volume of spray used for aerial treatment of persimmon. In ground spray treatments, 2 to 3 lb of 2,4,5-T acid per 100 gallons of water applied as a wetting spray generally was required for satisfactory control.

**Basal bark treatments:** Basal bark and ground line treatments have given good control on trees less than 6 inches in diameter. Concentrations ranging from 8 to 16 pounds of low-volatile 2,4,5-T ester in 100 gallons of diesel fuel were effective for most species. However, cottonwood and willow were controlled with the same quantity of 2,4-D ester. The basal bark treatments were effective at any time throughout the year. However, applications during the winter domant period until the buds begin to swell were generally preferred.

**Stump frill and cup treatments:** Sprouting on freshly cut stubs and stumps has been prevented by thoroughly wetting the tops and sides of the stumps, as well as any exposed roots, with a solution of 8 to 16 lb of 2,4,5-T ester in 100 gallons of diesel oil. This treatment was also effective applied in "frills". The same solution has been successfully used in "cups". Regrowth on stumps has also been prevented by application of ammonium sulfamate in dry form (95 percent concentration in the crystal form) or in a concentrated water solution (3 to 5 lb/gal).

**Soil applications:** Fenuron and monuron have satisfactorily killed oak and most associated woody species. These chemicals were effective when applied at rates of ⅛ to ¼ lb (approximately 7½ to 15 lb/A) of 80% active powder per gallon of water, with the spray being applied on the surface of the soil around each plant. Some effective results were obtained with pellets (25 percent concentration) on sandy soils. These chemicals were most effective during the dormant season. However, fair kills



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were obtained with treatments during the growing season. Fenuron or monuron in soil applications at 5 pounds active material per acre has not materially affected the growth of established grasses such as little bluestem, big bluestem, Indian grass, switch grass, and sand love grass.

**Arsenic:** Sodium arsenite in a liquid solution killed most of the hardwoods when placed in frills or injections. However, due to the highly poisonous nature of the chemical, its use is limited.

**Oil**: Kerosene and diesel oil when poured on soil around each stem also controlled a number of brush species. They suppressed the grasses and treatment costs with oils are quite high, thus they are not being used extensively.

**Mechanical methods:** The earliest methods of brush removal were by cutting with axes or saws. Powered saws were developed to reduce labor and time involved in cutting. Piling of brush was a problem. Metal buck rakes were developed and used very satisfactorily in the removal of brush after cutting. Various other machines such as mowers (whirling and sickle types), crushers, heavy duty sweeps, bull-dozers, and heavy drag chains have been tested for brush control. Each of these machines worked satisfactorily on areas where they could be operated efficiently. However, operational costs were generally too high for practical usage. Usually a number of treatments with the various machines were required to suppress regrowth.

Mowing especially when woody plants approached full leaf stage gave fair suppression of sand sage, shinnery, sumac, skunk brush and brambles. However, a number of yearly treatments generally were necessary to obtain sufficient control far a fair maintenance of native grass. Bull-dozing, crushing, dragging by chain, and sawing of tree size brush at various seasons of the year did not prevent sprouting.

**Browsing:** This practice has been studied extensively for control of sprouts. Goats have been found to be the best browse animals. They eat leaves and terminal twigs on most of the brush plants found in grass lands. Through intensive grazing for several years, goats will generally control and occasionally eliminate some species of brush. The goats also consume the desirable forage grasses and legumes in range and pastures. Their use for sprout control makes the improvement and maintenance of desirable forages a problem.

**Burning:** Fire to control brush has been investigated rather extensively. Burning, especially on woody species that do not sprout readily and when done so as to not injure the desirable grasses and legumes, is a fairly good range and pasture improvement program. This practice was used for several years as a spring treatment every third year for control of shinnery oak. The shinnery was kept under partial control with a fair maintenance of the native grasses. Burning was not satisfactory for control of post and black jack oaks and associated hardwoods.

## BRUSH ON RIGHTS-OF-WAY

**R. H. Beatty**

Thousands of acres of woody plants must be controlled on rights-of-way for construction, operation and maintenance purposes. Ingenious ways have been devised for doing this mechanically. However, utility companies look for more efficient and economical ways to control brush.

Chemicals such as arsenicals, chlorates and borates were tried, but found unsuitable except for spot treatment because of toxicity to livestock, fire hazard, bulk quantites required, or interference with grasses.

The primary chemicals now being used to control woody plants on rights-of-way are, 2,4-D, 2,4,5-T and ammonium sufamate. Mixtures of 2,4-D and 2,4,5-T are used to control mixed stands of woody plants. Amitrol, TBA and silvex are useful on certain susceptible species. Monuron and fenuron show promise as specialized soil treatments.

Three major application techniques have evolved—foliage sprays, stump treatment and basal sprays during active growth or dormant period.

**Chemicals:** Ammonium sulfamate was the first appropriate material to be developed, and is now used as a general purpose brushkiller. It proved to be non-volatile, relatively non-selective, and did not sterilize the soil, although foliage sprays burned herbaceous plants to the ground.

Most early investigations of the herbicidal action of 2,4-D on woody plants dealt with the effects of various formulations on different species and were of the field experiment type. The highly selective herbicidal effects of 2,4-D formulations were established, and it was found that 2,4,5-T killed some species that were resistant to 2,4-D. It also became apparent that combinations of 2,4-D and 2,4,5-T were more efficient than either chemical used alone; synergism was not implied.

Although it was evident that killing woody plants required a higher concentration of 2,4-D or 2,4,5-T (at least 3 pounds acid equivalent per 100 gallons of spray) than used for herbaceous species, evidence has accumulated that there are optimum rates of application for various chemicals on different plants and using different types of application. Beyond these rates, the addition of more chemical does not increase effectiveness.

Amine and acid formulations preceded the low-volatile ester formulations developed to reduce inadvertent spray injury. The latter have proved fully as effective as the older forms, and in some cases are better.

The newer chemicals being developed appear to be supplementary, and most useful for rather specific purposes. Amitrol is outstanding for control of poison ivy and white ash. TBA has defoliated persimmon completely and prevented resprouting during the two years following treatment. In general, the effect of silvex has been similar to that of 2,4,5-T. It has been outstanding on certain oaks. Monuron is promising for controlling scattered clumps of brush, and fenuron for pelleted aerial application.

**Application techniques**: At the same time new herbicides were being developed for right-of-way brush control, there were extensive attempts to improve results by changing application techniques. Initially, 2,4-D, 2,4,5-T, and ammonium sulfamate were used primarily as foliage sprays. Most applications were made during the succulent stage, but some species were reported killed by foliage sprays in late summer or the pre-dormant stage. Foliage sprays or ammonium sulfamate were found to be effective for some species resistant to 2,4-D or 2,4,5-T. Attempts to lengthen the spray period by applying concentrated sprays (1 to 2% 2,4-D, 2,4,5-T, or mixtures) in oil or water to the whole bush or to tree trunks were encouraging.

When foliage sprays were ineffective, sometimes applying the chemical to freshly cut stump surfaces was effective. Rates of 9 to 16 pounds of 2,4-D, 2,4,5-T or mixtures per 100 gallons of oil were found to be most suitable, with application to the top and sides of the stump with enough volume to completely wet them and any exposed roots. Ammonium sulfamate applied as crystals or as a concentrated water solution (3½ to 5 pounds per gallon) also proved effective for stump treatment.

It was found that 2,4-D, 2,4,5-T, or mixtures were effective when applied in oil to only the basal parts of woody plants. Small trees, usually under 6 inches in diameter, responded best to this type treatment, and thorough application (to the point of run-off) was essential. Such basal sprays were effective on some species resistant to foliage sprays.

As a carrier for basal sprays, none of the oils generally available seemed to be more effective than kerosene or fuel oil. Water was generally ineffective, even

when extremely concentrated sprays were used. However, emulsions containing 10 or 20 gallons of oil in 90 or 100 gallons of water were nearly as effective as oil alone. Apparently there was enough oil in them to effect penetration of the bark, and high volume sprays of these oil-water emulsions afforded a reduction in the costs of material and labor required for low-volume oil treatment of individual plants.

The dormant basal treatment technique developed as an attempt to extend the practical work period, minimize damage off the right-of-way, and increase the percentage of kill. There is evidence that dormant season applications may be more effective than growing season applications under some conditions. 2,4,5-T produced superior results for dormant brush control, better than 2,4-D or a mixture. One reason for this may be its ability to suppress dormant root and crown buds.

The basal area appears to be the most critical site of application for dormant treatment, as the lethal effects seem to move upward or at least appear above the point of application, but there is little or no downward movement. Apparently the central area of the stem can absorb chemical and move it to the terminal areas, which are in turn killed, but it does not retain an acute dosage itself. Thorough application to the basal area, in such volume that the spray runs down to the crown in considerable quantity, appears to be of utmost importance.

Autographs of bark, shoot tips and leaves of brush species treated with radioactive 2,4-D indicate that movement of this indicator parallels that of foods in these plants. Depending upon physiological activity, movement from a treated leaf may be downward to the roots, upward to growing shoot tips, or in both directions. It seems evident that to obtain successful treatment of brush species by the spray method it is necessary that the herbicide be absorbed, that photosynthesis be active to provide assimilates for movement in the phloem, that translocation from active leaves to an active sink in the roots be going on and that root activity involve meristematic activity and not merely storage.

Because brush species grow in mixed stands that contain both deciduous and evergreen species that blossom and vegetate at different times of the year, there can be no perfect time or condition for treatment, and the optimum is treatment keyed for the highest practical degree of control, rather than complete eradication.

## CHEMICAL DRYING AND PRE-HARVEST WEED CONTROL

**N. E. Shafer**

Chemical desiccation of crops and weeds was apparently initiated in the alfalfa seed producing areas of California and Arizona. The practice was underway as early as 1949 before much if any actual research had been done. Some exploratory investigations were carried out in the NCWCC area as early as 1949 and 1951. First published reports appeared in 1952 when 12 abstracts were submitted from 5 different stations. Since that time numerous chemical desiccants have been used on 16 different crops with varying results.

Crops tested have been as follows: wheat oats, barley, corn, grain sorghum, sudan grass, soybeans, field beans, flax, potatoes, alfalfa, sweet clover, red clover, alsike clover, Kentucky bluegrass, and switchgrass.

Chemicals used have been primarily contact herbicides with amitrol and dalapon as the main exceptions. Compounds tested may be conveniently grouped according to solubility in either oil or water.

| Oil soluble | Water Soluble |
|---|---|
| DNBP | Sodium cyanamid |
| DNAP | Sodium monochloroacetate |
| PCP | Sodium isopropyl xanthate |
| Phytotoxic oils | Sodium chlorate-sodium pentaborate |
| S,S,S-tributyl phosphorotrithioate | Endothal |
| | Magnesium chlorate |
| | Potassium cyanate |
| | Amitrol |
| | Dalapon |
| | DIPA |
| | Ammonium nitrate |
| | Ammonium sulfate |
| | Urea-ammonium nitrate |

Since most chemical desiccants are contact herbicides there is no danger of chemical translocation into roots of perennial crops. The same contact action requires thorough and uniform coverage for best results. Oil soluble chemicals are usually applied in No. 2 diesel fuel as a carrier or in oil-water emulsions. The water soluble chemicals must be applied in water and should have 0.1% to 0.2% wetting agent added to the final volume.

In the NCWCC area the main use for chemical desiccants would probably be as an aid in improving harvesting conditions for small seeded legumes. Chemicals have eliminated the need for mowing and windrowing the seed crop. Chemical desiccants allow direct combining which saves seed, saves time and may improve quality. Seed harvests have been increased as much as 49 lb for alfalfa and 80 lb for sweet clover. Effective chemicals must also dry weed growth which often interferes with seed harvest of many legume crops. Soybean, field bean and potato harvest may also be materially aided by the proper use of chemical desiccants. In certain areas pre-harvest spraying of potatoes and field beans is now a standard practice. In soybean areas desiccants tend to be used only in certain seasons or on certain sites when heavy weed growth occurs. Pre-harvest spraying of soybeans cannot be used to speed up maturity without an accompanying yield loss. Proper timing of the desiccant spray is important on all crops where such sprays can be used but in general treatment should not be made until the crop is at or near physiological maturity. Harvesting should take place as soon as moisture conditions permit.

**Alfalfa and alsike clover.** Spray as soon as most of the seed pods have turned brown. DNBP or DNAP at 1.25 to 1.87 lb/A or PCP at 4 to 6 lb/A applied in 5 to 10 gallons of diesel fuel per acre usually allows combining in 2 to 4 days. On heavy growth, retreatment at one-half the initial rate may be needed 1 to 2 days after the first treatment. Rate of treatment and volume of carrier should be varied depending upon density of foliage. The higher rates are also needed during the late fall when temperatures are lower. At temperatures below 60° F endothal at 1 to 1.25 lb in 20 gallons of water per acre has been equal or superior to PCP or DNBP. However, most reports indicate endothal is somewhat less effective in drying weed growth especially broadleaved weeds. In the major alfalfa seed producing areas airplane application is recommended to avoid seed losses from the wheels of ground sprayers. Swaths should be no more than 5 feet greater than the wing span of the aircraft. Spray volume is very important and should be no less than 5 gallons per acre. Higher volumes give improved results.

**Sweetclover.** Apply desiccants when one-half the seed pods are brown. Shattering is a serious problem in sweetclover seed production and attention should be given to wind and weather forecasts. Harvest just as soon as moisture conditions permit. Sweetclover dries rapidly following desiccant treatment since harvest generally occurs in July when temperatures are near maximum. Most consistent chemicals have been DNBP or DNAP at 1.25 to 1.87 lb/A, or PCP at 3 to 4 lb/A in 5



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to 10 gallons of diesel fuel per acre. Where weed growth is not a problem endothal may also be used at the same rates as for alfalfa. Apply desiccants by aircraft to prevent seed shattering.

**Red clover.** Pre-harvest spraying with desiccants may be started when most of the heads have turned brown and the seed is showing the typical red to purple coloration. Use the chemicals and rates as suggested for sweetclover.

**Soybeans.** Green weed growth may be effectively dried using chemical desiccants after most of the bean pods have turned brown. Earlier treatment may reduce bean quality and yield. Use DNBP or DNAP at 1.25 to 1.87 lb/A or PCP at 2 to 6 lb/A in 5 to 10 gallons of diesel fuel per acre. In areas or seasons where cold temperatures are encountered at harvest time, or when weeds are primarily grasses; endothal at 1 to 2 lb or magnesium chlorate at 5 lb in 15 to 20 gallons of water per acre may be more effective.

**Dry edible field beans.** Desiccants may be applied after pods have dried and beans have hardened. Successful treatments have been endothal at 1 to 2 lb/A, sodium chlorate-borate mixtures at 15 to 20 lb/A, or magnesium chlorate at 2.5 to 5 lb/A. To avoid wheel damage and shattering airplane application is suggested. Use 5 to 10 gallons of water per acre by airplane or 20 to 25 gallons by ground sprayer.

**Flax.** Endothal at 1.25 lb/A in 5 to 10 gallons of water per acre applied by aircraft or 20 gallons of water applied by ground equipment can be used to aid in drying weed growth and flax stems. DNAP, DNBP, or PCP may also be used if temperatures above 70° F. can be expected. Use the rates and volumes suggested for soybeans.

**Potatoes.** Pre-harvest vine killing has been a standard practice in potato production for many years. Use of vine killing chemicals enhances the action of mechanical vine beaters and in addition sets the skins on the tubers thus reducing the bruising and skinning associated with mechanical harvesting. Allow 7 to 10 days between treatment and digging. Sodium arsenite (40%) at 4 qt per acre in 5 to 10 gallons of water per acre by aircraft or 20-25 gallons by ground sprayer may be used. DNBP or DNAP at 1.25 to 1.87 lb/A in 5 to 10 gallons of diesel fuel per acre by aircraft or in 15 to 20 gallons of oil or oil-water emulsion by ground sprayer may also be used.

**Wheat, oats, and barley.** Treatments with sodium cyanamid, endothal, sodium isopropyl xanthate, and dalapon have shown little or no practical use for desiccants on these crops. Sodium cyanamid and endothal were most effective of the compounds tested. Oats appeared to be most sensitive to desiccant treatment. Possible use of other chemicals should be considered.

**Corn.** Most reports indicate little practical value for the use of chemical desiccants for reducing the moisture content of corn.

**Sudan grass.** Seed production fields may be treated when most of the seeds are mature. Like sweetclover, shattering is a serious problem. Harvest as soon as moisture levels permit. Moisture differences of 10 to 15% may result in one week following treatment with 4 to 6 lb/A of PCP in 5 to 10 gallons of diesel fuel per acre. PCP appears to "freeze" the seed on the plants in comparison with other desiccants or untreated sudan. DNBP, magnesium chlorate, sodium chlorate-borate mixtures or phytotoxic oil increased shattering. The addition of ½ lb of amitrol with magnesium chlorate completely inhibited axillary regrowth.

**Grain sorghum.** Chemical desiccants may be used to dry the foliage and upper stalks as an aid in easier combine harvesting. In certain areas treatment with desiccants may permit harvesting as much as one month in advance of the normal harvest date. Differences in seed moisture due to desiccant treatment may vary from none to as much as 10 or 15% in 7 days time. Variations in seed drying appear to be related to local climatic conditions and to differences in varieties or hybrids. Sorghum desiccation has been generally unsuccessful in the southwestern part of the region. In areas or seasons where rapid natural drying occurs untreated grain may lose moisture at a rate of 1 to 2% per day. Desiccant treatment does not increase this drying rate. Where natural drying is much slower desiccant treatment may reduce seed moisture 1 to 1.5% per day while untreated grain is drying less than 0.5% per day. PCP at 4 to 6 lb in 5 to 10 gallons of diesel fuel per acre should be used when grain is fully colored. Seed production fields may be treated when grain moisture ranges from 38 to 40%. PCP treated grain should not be fed to livestock. Where grain is to be fed use magnesium chlorate at 4 to 5 lb/A in 5 to 10 gallons of water if applied by aircraft. If ground sprayers are used a 15 to 20 gallon volume should be used. Directing 2 or 3 nozzles over each row will assure good coverage. The addition of 1 pint of a good wetting agent for each 100 gallons of water solution will give improved wetting and penetration of the desiccant.

**Switchgrass and Kentucky bluegrass.** Little has been done on the use of desiccants for grass seed harvest. Reports available indicate chemical treatment may be of value in reducing seed moisture and bringing about more uniform maturity at harvest time. Magnesium chlorate and sodium chlorate-borate mixtures appear to be more specific in drying grasses than DNBP or PCP.

## AQUATIC WEED CONTROL

**B. H. Grigsby**

Aquatic weed problems fall into three major groups based upon growth habits of the weed species. The relative importance of each group is dependent upon the normal use of the water area. The groups are (1) floating weeds, including the algae, (2) submerged rooted weeds, (3) emergent rooted species, including shore-line species such as cattail, rushes, etc.

Use of chemicals for aquatic weed control is limited by the nature of the chemicals commonly available, use of water, and by economics of application (cost of chemical per unit area, cost of application, and recurring infestation).

**Algae.** Control of algae has long been practiced in water reservoirs and recreational waters. The chief chemical agent has been copper sulfate. Dosage suggestions vary with the alkalinity of the water but generally range from 0.3 to 1.0 ppm, using an average water depth of 2 feet for calculation purposes. This depth is selected because the copper solution is active for only a short period of time and penetration beyond 2 feet before inactivation occurs is not likely to occur. When translated to an area basis the one ppm dosage is equivalent to about 5.5 lb/A copper sulfate. In spraying operations, a solution of 2 to 5 percent copper sulfate is applied in sufficient volume per unit area to give the required ppm concentration.

Sodium arsenite is an effective algacide at concentrations of 2-5 ppm and is used in water where arsenic toxicity is not a hazard to normal use of the water.

Experimental work in recent years has shown that some of the newer herbicides also have algacidal properties and many of these are non-toxic to fish and other animal life and may not affect other use of the treated water. Effective control has been reported from applications of the following: dichlone at 0.1 to 0.5 ppm; delrad; simazin at 5.0 to 10.0 ppm; diuron at 10.0 to 20.0 ppm; and CDEC at 10.0 to 20.0 ppm.

**Submerged rooted aquatics.** The most troublesome weeds in this group are: various species of pondweeds *(Potamogeton* spp.), water milfoil *(Myriophyllum* spp.), coontail *(Ceratophyllum* spp.), water weed *(Elodea* spp.), and water crowfoot *(Ranunculus* spp.).

The standard control measure for this group of weeds has been sodium arsenite at concentrations of 5-10 ppm based on total volume of the treated area. Treatments frequently are made on a strip basis to prevent fish killing and other undesirable conditions. Best results are obtained when sodium arsenite is applied at a time when weed growth is active but before shoots have reached the water surface. Repeat applications are required in some seasons and a single season of treatment seldom brings about eradication of water weeds. Treated water should not be used for stock watering, swimming, or fishing for at least 36 hours after treatment. Arsenite treated water should not be used for irrigation purposes.

Water milfoil frequently fails to respond to arsenite treatment and in mixed stands of water weeds such treatment may increase the amount of milfoil present. The destruction of other species reduces the competition and milfoil thus is able to spread extensively.

Arsenite concentrations in excess of 10 ppm may be toxic to fish and should not be applied to large areas of water.

Because of the numerous problems associated with the use of sodium arsenite, search for other suitable chemicals has been intensified and some encouraging results found. Chemicals that have been tested and give favorable results include: silvex at 40 lb/A; neburon at 30 lb/A; TCB at 40 lb/A; 2,4-D ester at 40 lb/A; 2,4-D ethanol at 40 /A; simazin; and dichlone.

Many of these herbicides have been applied as granular formulations and the dosage calculated on a bottom area basis without regard to water depth. In this method, an attempt to destroy root systems is made and no particular attention is given to foliage or stem contact. Application may be made on open water, or in regions where firm ice forms, the dry herbicide can be applied to the ice surface just before spring thaws occur.

**Emergent species.** Cattail, rushes, phragmites, water smartweed and water lilies are found in shallow water, ditches, artificial ponds, etc.

Effective control measures for all of these have been found in recent investigations. Dalapon at rates of 10-20 lb per 100 gal of water is widely used for the control of cattail, phragmites, rushes and various grasses. Similar results with 10-20 lb of amitrol have been reported.

Emergent broadleaved species generally can be controlled by applications of 2,4-D, silvex and amitrol. The rates of application range from 2 to 4 pounds and with 2,4-D and silvex greater effectiveness is obtained by applying the herbicides in fuel oil or kerosene. Dosage rates are in pounds per 100 gallons of diluent and repeat applications frequently are required for eradication. The usual precautions for protection of other vegetation are used.

Use of herbicides in public water is regulated by the Departments of Conservation, or Water Resources in most of the North Central states and all applications are made on a permit basis. Commercial applicators must conform to the regulations of the state in which the treatment is made.

## NEW HERBICIDES

**J. H. Davidson**

The potential value of chemical weed control in agriculture became more fully realized during World War II. Prior to this time, chemicals for weed control were limited to herbicidal oils, non-selective arsenicals, borates, chlorates, and a few other inorganic salts. The introduction of 3,5-dinitro-*o*-cresol, ammonium sulfamate and 2-*sec*-butyl-4,6-dinitrophenol in the period of 1938 to 1944 stimulated further investigation of synthetic organic chemicals during the following years until there are now at least 30 different chemicals used commercially for vegetation control.

For the purpose of summarizing the so-called new chemicals for 1958, only those compounds not listed on pages 280 and 281 of WEEDS, Vol. 4, (No. 3), July, 1956, will be considered. A total of 65 abstracts was received. The numbers of 1958 abstracts received is indicated by the number in parenthesis after the chemical.

The new chemicals which have appeared and remained useful during this period can best be reviewed by grouping according to their chemical structure.

**Aryloxy compounds.** The present day widespread use of 2,4-dichlorophenoxy acetic acid at rates ranging from 4 ounces to 8 pounds per acre attests to its value in the control of many species of broardleaved plants in crops and non-agricultural land. Problems of controlling the spray so only unwanted vegetation is destroyed have resulted in the development of low volatile esters and amine salts. The use of non-volatile forms of the chemical in invert emulsions to reduce spray drift is an additional attempt to control 2,4-D applications in the vicinity of sensitive crops.

Other related aryloxy compounds investigated include 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 2-methyl-4-chlorophenoxyacetic acid (MCPA), 3,4-dichlorophenoxyacetic acid (3,4-DA), 4-chlorophenoxyacetic acid (4-CPA), and the propionic and butyric acid analogues of the above. Of these chemicals, only a few have become commercially important. 2,4,5-T and its propionic analogue, silvex, have been superior to 2,4-D on certain species of woody plants. Silvex has also shown promise for control of certain aquatic weeds as well as a number of broadleaved turf weeds. MCPA used in the amine and certain other salt forms has been safer than 2,4-D on canning peas, flax, clover, and certain other legumes. The butyric acid analogues of 2,4-D 4-(2,4-dichlorophenoxy)butyric acid) and MCPA (4-(2-methyl-4-chlorophenoxy)butyric acid) have shown desirable specificity for control of certain broadleaved weeds in legumes. 2-(2,4,5-trichlorophenoxy)ethyl 2,2-dichloropropionate (erbon) combines the properties of 2,4,5-T and dalapon into a single compound that has been useful for controlling all types of vegetation when used at rates of 120 to 100 lb/A.

Ethyl sulfates of certain of the above acids give compounds which may not be directly toxic to established plants but are toxic to germinating seedlings as a result of breakdown in the soil.

Tris-(2,4-dichlorophenoxy)ethyl phosphite (3Y9) (4 reports) has been tried as a pre-emergence spray on turf, vegetables and field crops at rates ranging from 2 to 8 pounds per acre. Results have been variable.

**Chloroaliphatic acids.** The aryloxy herbicides listed above are mostly selective for the control of broadleaved vegetation. Derivatives for several chloroaliphatic acids are effective for the selective control of grasses. Trichloroacetic acid (TCA) at rates ranging from 40 to 100 pounds per acre, used mostly as the sodium salt, is effective for killing perennial grasses. At lower rates, it is useful for the selective control of annual grasses in tolerant crops. 2,2-Dichloropropionic acid (dalapon) used as the sodium salt, is effective against grasses at lower rates. Dalapon is about equal to TCA when compared as a soil application, but is much more effective when applied as a foliage spray on actively growing grass. Crops such as potatoes, certain legumes, sugar beets and flax are tolerant to rates of dalapon effective for the control of many annual and some perennial weedy grasses. Repeat applications of low rates of dalapon have provided excellent control of Johnsongrass and other perennial grasses, and may be safely used for grass control around fruit and ornamental plants and asparagus. Dalapon has also been effective for the control of cattail and phragmites.

Combination sprays of dalapon with 2,4-D or silvex are useful for vegetation control on railroad track areas. Trials with foliage applications of 2,2,3-trichloropropionic acid as the sodium salt at rates ranging from 5 to 20



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pounds per acre were found to be generally less effective than dalapon. As a pre-emergence soil application, it is similar to dalapon and TCA. Sodium 2,3-dichloroisobutyrate (FW-450) has been evaluated for grass control, but generally it is not as effective as TCA or dalapon. The combination of tillage with foliage sprays of all these materials generally improves results on perennial grasses.

**Arylaliphatic acids.** 2,3,6-Trichlorophenylacetic acid (1 report) was tested for control of bindweed and Johnsongrass. The amine salt at rates above 10 pounds per acre eradicated bindweed. Eighty pounds per acre was required for 100% control of Johnsongrass.

**Substituted ureas.** A series of substituted ureas with variable soil residual properties were found to be useful for weed control in crops and total vegetation control in non-agricultural areas. 3-(*p*-chlorophenyl)-1,1-dimethylurea (monuron) was the first of this series to be tested. At rates of 20 to 40 pounds per acre, it is effective in destroying most vegetation. At reduced rates of 1 to 3 pounds, applied as a pre-emergence spray in certain crops such as asparagus, selective weed kill is possible. Other related compounds which are used as pre-emergence sprays are: 3-phenyl-1,1-dimethylurea (fenuron), 3-(3,4-dichlorophenyl)-1,1-dimethylurea (diuron), and 1-*n*-butyl-3(3,4-dichlorophenyl)-1-methylurea (neburon). A certain amount of selective action is possible from these chemicals applied to the soil. Neburon has shown selective activity against certain turf weeds and is useful around many nursery crops. Fenuron may be useful for woody plant control without excessive damage to perennial grasses.

Dichloral urea (DCU), used at the rate of 6 lb/A as a pre-planting treatment incorporated in the soil, is useful for grass control in sugar beets.

**Carbamates and thiocarbamates.** Isopropyl *N*-phenylcarbamate (IPC) was the first of this group to be used for pre-emergence weed control. Results were promising for grass control in soybeans and red clover at rates of 4 to 8 pounds per acre but caused some injury to corn. Results were poor for control of perennial grasses. Isopropyl *N*-(3-chlorophenyl) carbamate (CIPC) generally is more effective than IPC, and may be used for pre-emergence weed control in soybeans, onions, and certain other vegetable crops. 2-Chloroallyl diethyldithiocarbamate (CDEC) is used as a pre-emergence spray for certain vegetables. Variable results from this group of materials may be partially due to their volatility.

Ethyl *N*,*N*-di-*n*-propylthiolcarbamate (EPTC) (27 reports) worked into the soil as a pre-planting or pre-emergence treatment at rates of 2 to 10 pounds per acre has been used effectively to control annual and perennial grass seedlings. At the higher rates, some indication of controlling perennial grass plants has also been obtained. Many crops appear to be tolerant to pre-planting treatments when suitable weather and interval between treating and planting occur. Small grains are not very tolerant. The effect of environmental factors is minimized when EPTC is incorporated in the soil.

4-Chloro-2-butynyl *N*-3-chlorophenylcarbamate (S-847) (6 reports) is the latest addition to this group of herbicides. It appears to have selective action against wild oats in small grains at rates ranging from 1 to 4 lb/A when applied as a foliage spray.

Sodium *N*-methyldithiocarbamate dihydrate (SMDC) (2 reports) is an effective pre-planting residual soil herbicide which has proved useful for the control of conditioned* weed seeds and other soil pests. Its effective use is dependent upon its being carried into the soil with water or through mixing. A sufficient interval between treating and planting is necessary to avoid crop injury.

**Acetamides.** Several chemicals in this series have been investigated. 2-Chloro-*N*,*N*-diallylacetamide (CDAA) is useful as a pre-emergence spray for weedy grasses and certain broadleaved weeds at rates of 4 to 6 lb/A in corn, soybeans and onions. 2-Chloro-*N*,*N*-diethylacetamide (CDEA) used as a pre-emergence spray has not been as satisfactory in most cases as CDAA.

Alpha-chloro-*N*-ethyl-*N*-phenylacetamide (CP-6936) (7 reports) used as a pre-emergence treatment at the rates of 4 to 8 lb/A has shown promise for control of weedy grasses and broadleaved plants in corn, soybeans, and certain vegetable crops. The higher rates are required on muck soils.

2,6-Dimethylphenyl-alpha-chloroacetamide (ACP:M-625) (2 reports) when used as a post-emergence foliage spray for selective control of wild oats in grain gave poor control of wild oats.

**Heterocyclic nitrogen compounds.** The first of this group to show herbicidal activity was 3-amino-1,2,4,triazole (amitrol). This compound showed poor pre-emergence activity, but as a foliage spray at the rates of 4 to 10 lb/A it has been effective for the control of Canada thistle, poison ivy, cattails, and certain other special uses. A characteristic reaction on plants is a foliage chlorosis.

Certain of the triazines have shown useful herbicidal activity. 2-chloro-4,6-bis(dimethylamino)-*s*-triazine (Chlorazine) was the first of these compounds. Corn and carrots are tolerant to rather high rates, but other crops are injured. Later, 2-chloro-4,6-bis(ethylamino)-*s*-triazine (simazin) (28 reports) was shown to be useful for control of weedy grass and broadleaves in corn at rates as low as 2 lb/A applied pre-emergence. It may also be useful for the control of annual weedy grasses in established alfalfa. Trials on muck soil for weed control in certain vegetables were not satisfactory at 2 lb/A. Four lb/A is required in many cases. Corn is tolerant to rates as high as 14 lb/A, but residues left in the soil may be toxic to some crops the following season. Crops other than corn are not very tolerant. This limitation has been partially overcome by new related compounds which show more apparent specificity as pre-emegrence treatments and also promise as post-emergence sprays.

2-Chloro-4-ethylamino-6-diethylamino-*s*-triazine (Trietazine) (10 reports) was used at 2 to 8 lb/A as pre-emergence spray with good control at rates above 4 lb. Promising results were obtained as a pre-planting treatment for tobacco transplants.

2-Chloro-4,6-bis(isopropylamino)-*s*-triazine (Propazine) (1 report) used at rates of 4 and 8 lb/A as a pre-emergence spray for sorghum gave good control of pigweed with no crop injury.

2-Chloro-4-isopropylamino-6-ethylamino-*s*-triazine (Atrazine) (2 reports) used pre-emergence at rates of 1 to 4 lb/A in corn gave good control of green foxtail, wild oats and pigweed. When used as a pre-planting treatment for tomato transplants, it proved too injurious. It may have some use as a contact post-emergence treatment.

2-Chloro-4-methylamino-6-isopropylamino-*s*-triazine (G-30026) (3 reports) used at rates of 1 to 4 lb as a pre-emergence spray did not give satisfactory results.

2-Methoxy-4,6-bis(isopropylamino)-*s*-triazine (Methoxy Propazine) (1 report) applied as a foliage spray at 20 pounds per acre on Johnsongrass gave 80% control of the rhizomes.

2-Methoxy-4,6-bis(ethylamino)-*s*-triazine (1 report) used as a pre-emergence spray at 4 to 8 lb/A gave fair control of pigweed in sorghum and caused slight injury.

2-Chloro-4-*n*-propylamino-6-isopropylamino-*s*-triazine (1 report) used at 4 to 8 lb as a pre-emergence spray in sorghum gave only moderate control and caused injury.

2-Chloro-4-diethylamino-6-isopropylamino-*s*-triazine (Heptazine) (3 reports) used pre-emergence at 4 lb/A gave good weed control in sorghum with no injury. When used in peas underseeded to alfalfa, there was damage to the alfalfa from the pre-emergence applications. Post-emergence applications on peas killed annual grass but also injured peas.

3-5-Dimethyltetrahydro-1,3,5,2H-thiadiazine-2-thione (DMTT) (1 report) used as a pre-planting drench treatment of seed beds and transplant areas at 290 lb/A was effective for controlling weed seeds that are ready to germinate. An interval of 3 weeks was necessary



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between treating and planting when such vegetable crops as carrots, onions and peas are planted on treated soil.

**Arsenicals.** Certain inorganic arsenicals have long been recognized as effective herbicides. Their action has been residual in the soil or by contact. Several new organic arslnicals are useful selective contact herbicides for controlling crab grass in turf. Disodium monomethyl arsonate was the first of these new arsenicals. Octyldodecyl ammonium methyl arsonate (AMA) (1 report) used at 0.8 to 1.6 oz/1,000 sq ft as an early post-emergence spray gave good crabgrass control in bluegrass turf with no injury.

**Polychlorobenzoic acids.** 2,3,6-Trichlorobenzoic acid (2,3,6-TBA) (6 reports) was used both as a foliage and soil application for vegetation control. Leafy spurge and Russian knapweed can be controlled with a soil residual application of 20 to 40 lb/A. Lower rates of 1 to 4 lb/A in corn, under certain conditions, have given fair weed control without injury. As a non-selective foliage spray, many annual weeds have been controlled with 10 lb/A.

Mixtures of TBA with di-, tetra- and pentachlorobenzoic acids have been tested as polychlorobenzoic acids (PBA) (4 reports). In general, the results are similar to those reported for TBA.

2,5-Dichloro-3-nitrobenzoic acid (ACP M-460 and M-503) (4 reports) used as a pre-emergence spray at 4 to 8 lb/A on soybeans and corn for annual weedy grass and broadleaved weeds gave good control with no injury. Six lb/A for potatoes in muck gave poor control and slight injury to potatoes. Pre-emergence treatments on peas caused injury.

3-Amino-2,5-dichlorobenzoic acid (ACP M-629) (1 report) used pre-emergence at 4 lb/A in soybeans gave excellent weed control with no injury. At 1 lb/A control was good.

A mixture of chlorinated benzoic and cresoxyacetic acids was tested under the number CP-1815 (7 reports). Foliage applications of ½ to 16 lb/A were tested. For most weeds, at least 8 to 10 lb were required for satisfactory kill. Selective weed control with the lower rates was poor.

**Cyanamide and cyanates.** Calcium cyanamide incorporated into the soil under suitable temperature and moisture conditions is an effective method of killing weed seeds. In the dust grade it is used as a contact weed killer on small weeds.

Ammonium and potassium cyanates have been used with partial success in turf for crabgrass control. KOCN is also a fair selective pre-emergence treatment for weeds in cetain vegetable crops.

**Miscellaneous chemicals.** Disodium 3,6-endoxohexahydrophthalate (endothal) (4 reports) has been investigated for several years and appears to be useful for weed control in sugar beets when used as a pre-emergence treatment of 8 to 12 lb/A.

Maleic hydrazide (MH) frequently exhibits the property of inhibiting plant growth without killing the plant. Its usefulness in the herbicide field is questionable, although some good results in quack grass control have been reported.

*N*-1-naphthyl phthalamic acid (NPA), used as the sodium salt, has shown some selective action as both a post-emergence and pre-emergence spray for annual weeds and grasses in cucumbers, melons and field beans.

Ethyl xanthogen disulfide (EXD) and isopropylxanthic acid (IPX) are used as pre-emergence sprays on onions and certain other vegetables.

Pentachlorophenol (PCP) can be used in oil and emulsified in water or as the sodium salt dissolved in water. It is effective as a contact herbicide and has residual pre-emergence properties for large seeded crops.

Hexachloroacetone (HCA) (4 reports) and hexachlorocyclopentadiene (C-56) (2 reports) have been used to fortify oils as a means of improving contact effect on established grass plants. Their value is not always clearly indicated. One report indicated control of Johnsongrass in corn from a foliage application of C-56 alone.

1,2,3,4,5,6,7,8,8-Octachloro-4,7-methano-3a,4,7,7a-tetrahydroindane (chlordane) has given good control of crabgrass in turf when applied before germination and emergence.

Phenyl mercuric acetate (PMA) as a selective foliage application on young crabgrass has given variable but often satisfactory results.

3,4-Dimethylbenzophenone (3,4-DMB) used pre-emergence in corn has given indications of selectively controlling annual grasses.

Methyl bromide is extensively used as a pre-planting treatment for seed beds and preparing areas for transplants. It is a gas under normal conditions and must be confined to the area by a gas-tight cover.

Allyl alcohol applied as a pre-planting drench has shown promise for weed seed control, but is objectionable to handle.

1:1'-Ethylene-2:2'-bipyridinium dibromide (FB-2) (8 reports) has been used at rates ranging from 0.25 to 4 pounds per acre as a contact foliage spray. There appears to be little or no selective action for weed control in crops. In one report, 90% control of hemp nettle was reported from an application of 2 lb/A.

* About to germinate.

## MECHANICAL CONSIDERATIONS

**W. G. Lovely**

Mechanical considerations in a comprehensive program of weed control include the proper use of seed cleaning, tillage, chemical application, and harvesting equipment. No one machine or operation in the above group will give satisfactory weed control when used exclusively without regard for the others. Prior to the discovery of 2,4-D and other herbicides the major emphasis was on mechanical or cultural methods of weed control. This changed with the advent of 2,4-D and the emphasis for several years was on herbicides and equipment to apply them. For the past 3 or 4 years weed researchers have been taking a new look at the old mechanical and cultural practices. New and better herbicides and equipment for applying them will be developed along with new and improved equipment for mechanically controlling weeds.

The major interest in the next few years will be in the development of weed control systems (combinations of seedbed preparation, herbicide applications, and cultivations) that will give the most effective and economical control of weeds. Granular formulations of herbicides will continue to be tested and if the promising results continue, additional application equipment will be developed.

**Seed cleaning.** It is important that all seed used be free of weed seed. To avoid weed seed contamination, either clean seed thoroughly or purchase from reputable dealers. Most seed separation problems can be solved by taking advantage of differences in physical characteristics of the seeds. Some of the common methods of separation and the physical differences which are the basis of their operation are as follows: (1) fan and screen method—size, weight, and shape; (2) indented disc and cylinders—length; (3) gravity table—weight; (4) gravity spiral separator—shape; and (5) fabric covered rolls—surface texture. If a special cleaning problem exists, many seed firms have specialized equipment to do the job.

**Tillage equipment.** Prior to planting, tillage operations accomplish two things: first, the soil is tilled to put it in a physical condition that will be conducive to maximum plant growth; secondly, and of equal importance, tillage operations are performed to give maximum control of weeds. After the crop has been planted the major reason for most tillage is to control weeds. Timeliness, speed and proper tool adjustment are of vital



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importance for effective weed control in all tillage operations. All three variables should be given careful consideration in connection with soil type conditions and crop.

Adjustments are especially important in the use of cultivation equipment. Shovels, sweeps, points, discs, and other tools used on cultivators will require specific arrangements and adjustments. These tools should be adjusted to overlap properly and to operate at the proper speed and depth to give maximum control of the weeds between rows and at the same time give as much weed control as possible within the crop row and yet avoid injury to the tops or pruning of the roots of the crop plants.

Proper timing is most essential for effective use of shallow cultivating tools such as rotary hoes and weeders. These implements can best aid in controlling shallow germinating annual weeds in corn and soybeans only if used when the weeds are in the small seedling (white) stage. Soil moisture conditions at the time of the operation are less important than conditions following treatment in that warm drying conditions will result in better weed control than cool wet conditions. Depth and speed should be adjusted to fit the specific conditions encountered.

**Chemical application equipment.** In selecting an herbicide applicator, careful consideration should be given to its service and possible repair. For this reason reputable dealers and manufacturers capable of furnishing service and parts are the best source of equipment.

**Ground sprayers:** Farm sprayers should be selected on the basis of overall spraying requirements and not for weed spraying only. The sprayer features that should be considered are as follows:

1. The tank should be strong enough to withstand the pressures of the fluid inside and of a size which can be easily maneuvered through the field. Provisions should be included for easy and complete draining. An opening should be provided which will allow for cleaning the inside when necessary. It is important to have agitation within the tank either by mechanical means or by sufficient by-pass from the discharge line.
2. The suction strainer should be fine enough and of sufficient strength to remove as much foreign material as possible from the solution but of a size that will not throttle the suction of the pump.
3. The pump should be of sufficient capacity and quality to maintain adequate working pressures and flow to meet the conditions set by the spraying operation. It can be expected that most pumps will lose a part of their efficiency through normal use, and this should be considered in the pump selection.
4. The regulating valve and pressure gauge should be within easy reach and sight of the operator. The marked increments of the gauge should be such that pressures can be judged accurately over the full range of spraying pressures contemplated.
5. Booms should be suitably hinged to reduce breakage and to permit convenient transportation. The hinge should be rigid enough to prevent the boom from swinging back and forth during the spraying operation and yet allow for release if any obstruction is hit. They should be of sufficient size to prevent a significant pressure drop at the end nozzles and have removable plugs in the ends to facilitate cleaning.
6. In view of the wide range of recommended spray application rates, special care and attention should be given to the selection and performance of the nozzles. They should be uniform in output and in the spray pattern which each produces.
7. Other features essential to a good sprayer are a quick acting shutoff valve, line filter between the pump and boom, individual filters at each nozzle and some device for measuring the fluid in the tank.

Even distribution is the most important characteristic of a good weed sprayer. Each nozzle and each square foot of area must be checked for even pattern and consistently even spraying. The sprayer output should be calibrated to each particular spraying operation. The calibration should be checked frequently during the operation to check for such things as nozzle orifice wear, clogging, etc. A speedometer on the tractor or sprayer can be very helpful for quickly detecting any change in speed which will affect the calibration.

A strict cleaning program should be followed after each use of the sprayer. This should include not only flushing the tank, pump, boom and nozzles, but also cleaning the exterior of the equipment. When the sprayer is prepared for winter storage, all bare metal parts should be coated with oil and the hose should be disconnected. The nozzles should be disassembled, cleaned, and kept in a container of oil. Pumps should be cleaned and stored according to manufacturers' specifications.

With broadcast boomless type sprayers, most uniform results can generally be obtained at 30 psi pressure in still air (less than 4-7 mph wind). Double coverage by overlapping half a swath will enable the operator to control his swath width better and will give more uniform coverage. If there is any breeze, the spraying should be done with the tractor traveling crosswind and overlapping one-half the swath width. Calibration is just as important as with conventional sprayers, and should be based on the actual effective swath width.

**Aerial sprayers:** Aerial applications of herbicides are economically advantageous and often more effective than other methods under many conditions. Factors to be considered in determining these advantages are: Size of area to be sprayed, time available for treating a given area, inaccessibility of the area to other equipment, suitable weather conditions, proximity of other crops which may be damaged by drift, comparative results and costs of aerial applications as against results and costs of other methods.

Even distribution is essential in aerial herbicide applications with a minimum of drift. The swath width should be limited to the wing span, or at most should be no more than 125 percent of the wingspan. The altitude should be as close to the foliage as safety of the pilot and equipment will permit (boom 4 to 5 feet above foliage on flat terrain and even growth; more clearance as necessary on uneven growth and terrain). The plane should be operated crosswind in order to maintain constant ground speed; but where it is necessary to fly parallel to the wind, flights can be made both up-wind and down-wind providing the pilot can control his airspeed so the ground speed will be constant; otherwise, they should be made up-wind only.

Spraying should be done when the wind is constant in direction and as low in velocity as possible. Large droplets minimize probability of drift; therefore, nozzles with large orifices should be used at low spray pressure. When it is necessary to increase the rate of spray application, it generally should be accomplished by increasing the number of nozzles, orifice size or other means rather than by increasing the spray pressure. Nozzles should be directed downward and to the rear. Each nozzle should be equipped with a positive shut-off. Light oil diluents break up in finer droplets than water because of lower surface tension; therefore, water or mulsions should be considered where drift present a hazard.

The following wind velocities are suggested as possible maximums for these representative conditions, but the operator's judgment and local conditions such as the proximity of suceptible crops will be the final determining factor:

| | Wind velocity |
|---|---|
| 2,4-D in mixed farming area at 1-2 gal/A | 5 mph |
| 2,4-D in mixed farming area at 5 gal/A | 7 mph |
| 2,4-D in range country at 1-2 gal/A | 7-10 mph |
| Chemical desiccants anywhere at 5-8 gal/A | 8-10 mph |



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Many chemicals separate out of suspension or emulsion when allowed to stand. Each plane load should be mixed just prior to take-off or the spray solution in an auxiliary tank should be thoroughly agitated just before each plane load is removed from it. It is desirable that each plane be equipped to provide agitation in the tank either as return flow or by use of a positive agitator.

The following are considered desirable features of aerial spray equipment:

1. The spray tank should be of light weight material. Fiberglass reinforced plastics, aluminum, and stainless steel are preferred for corrosion resistance. Metal tanks which leak or crack at the seam may often be repaired by lining them with fiberglass reinforced plastic. The tank should have a large filler opening to allow for easy cleaning and filling and should be adequately vented to allow for maintaining constant flow. If the tank is large in fore and aft dimensions, baffles should be installed to prevent surging.
2. Positive displacement pumps of the gear type produce excessive pressures and require a relief valve in the pressure line to prevent damage to the plumbing system. Centrifugal pumps in general do not produce excessive line pressures and do not require a relief valve for that purpose; however, such valves are advisable for maintaining constant spraying pressures and to maintain agitation in the supply tank. Pumps driven by external fans should be equipped with a brake assembly while direct engine drives require a clutch.
3. The boom should be large enough to prevent a significant pressure drop at the end nozzles, and the ends should be fitted with caps for cleaning. Round booms produce more drag than streamlined ones, but they are easier to clean. The boom should have fewer nozzles in the 3- to 4-foot space left of center and more nozzles to the right of center to overcome the spray displacement caused by the propeller slip stream. If nozzles are added to increase volume, they should be located in specific positions in a compensated arrangement to give optimum pattern rather than being placed at random. To minimize the effect of the wing tip vortex, no nozzle should be placed within 5 feet of the wing tip. On high wing monoplanes, lowering the outer ends of the booms so there is approximately 3 feet between the boom and lower wing surfaces aids materially in reducing wing tip swirl.

**Granular application equipment.** There are two general types of equipment that can be used to apply granules. First, is the 'seeder-type,' this includes fluted wheels, augers, fluted shafts, reciprocating chains, and gravity feeds. Second, is the 'duster-type,' and this includes most crop dusters. The metering device should meter the granular material accurately with a minimum amount of particle breakdown. Some of the seeder-type mechanisms are loosely constructed and should not be used for granular herbicides because of the excessive leakage that may occur.

Uniform distribution of the granules over the treated area is essential for maximum control, and therefore the spreading device is very important. It should be constructed so that the granules cover the area uniformly and not in strips or bands.

The 'air-blast'from most dusters causes the granules to become air-borne, and as a result more subjected to drift. Most dusters can be modified to handle granules satisfactorily by reducing the agitator speed to avoid excessive particle breakdown and by reducing the fan speed to reduce the air-blast. It is sometimes necessary to use a spreader device on the end of the air hose to further reduce the air-blast and to obtain a more uniform distribution of granules.

**Harvesting equipment.** As an aid in preventing the spreading of weed seed, it is important that a strict cleaning program be set up and adhered to before moving the machine from the field, particularly on machines which are used on a large number of farms. Each machine should be inspected to determine the places (flat areas, corners, and depressions) where weed seed is prone to collect during normal operation. The removing of dirt and weed seed from such places by compressed air, brushes, or other special equipment should be included in the cleaning process.

## BASIC STUDIES IN BOTANY, ECOLOGY AND PLANT PHYSIOLOGY

**W. E. Loomis**

From an early emphasis on screening of herbicidal chemicals, there has grown a very general tendency among all of the workers within the Conference area to emphasize basic aspects of their studies. Probably all of our members subscribe to the principle that no problem is completely and satisfactorily solved until the mechanism of its solution is explained and fully understood.

On this basis there is, of course, much to be done before we understand all aspects of the development of weeds, of their competition with each other and with crop plants, and of the absorption, translocation and toxic action of chemicals. Our summary at the present time is more one of problems remaining than of problems solved.

**Botany and ecology.** The sequence of the developmental phases of weeds needs much more study. We are finding that the control of one species frequently leaves dormancy and germination of the seeds of weeds, particularly of annuals where prevention of germination can constitute control. Complicated interactions of temperature, moisture and gases, particularly $CO_2$, are involved as well as embryo and seed cost factors. In general an annual weed, as contrasted to an annual plant, is a species with dormant seeds which germinate only under narrowly prescribed conditions.

Growth and fruiting of weeds may be controlled by temperature and photoperiod as well as by moisture and fertility conditions. Competition of weeds with weeds or with crops seems to be more for nutrients and less for water than formerly assumed. Effects of soil $CO_2$ levels on the growth and absorptive action of roots are undoubtedly involved also. Even though these effects are small and their action temporary, they can result in major effects at the end of the season.

**Plant physiology.** Physiology is a part of development and competition. Also, the success of a differential herbicide or the control of perennial plants by chemicals is largely determined by physiological factors. We have learned that young leaves are more susceptible to many spray treatments because of the incomplete development of their cuticular layers; that translocation is a physiological process dependent upon available sugars, suitable temperatures and no more than mild levels of toxicity in the phloem tissues at any one time; and that resistance can arise from failures of translocation, particularly in perennials, from chemical combinations that reduce the toxicity of the herbicide, from protroplasm that does not react with the toxin or, conversely, from protoplasm with relatively violent reactions in which the herbicide is destroyed so that the remaining portions of the plant recover and grow rapidly.

The many unsolved basic problems insure a continuing challenge to workers in the field of weed control. The progress to date promises an eventual solution to many of these important problems.



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# RESEARCH REPORTS

## North Central Weed Control Conference

### CONTROL OF HERBACEOUS PERENNIAL WEEDS

### JOHNSONGRASS[1]

**Control of Johnsongrass, quackgrass, and nutgrass with EPTC. Antognini, J., H. M. Day, R. Curtis, and G. F. Probandt.** EPTC at a rate of 4 lb/A as a preplanting soil incorporation treatment or as a soil incorporation treatment immediately after seeding has given excellent seasonal control of both seedling and established Johnsongrass and quackgrass in experimental and commercial applications. Both species of nutgrass have also been controlled for the season. The method of application for preplanting treatments has been a broadcast spray followed immediately by discing four to six inches deep in two directions and seeding. In the case of application immediately after seeding (this method had been used primarily on corn) over-all sprays or band sprays over the row are used followed by harrowing or discing parallel to the rows and to a depth of approximately 2". Crops which have been successfully seeded immediately following treatment include carrots, corn, snap and dry beans, flax, alfalfa, and the clovers. In addition to the above weeds most annual grassy and broadleaf weeds are also controlled with EPTC. (Contribution from Stauffer Chemical Company, Research & Development Department)

**Soil residues of dalapon and erbon. Appleby, A. P. and Anderson, L. E.** Dalapon at 15 lb/A and erbon at 80 lb/A were applied directly to adjacent areas of silt loam alluvial soil in May, 1957. Both herbicides were worked into the soil with a springtooth harrow. Corn, grain sorghum, sudangrass and soybeans were planted in four replications across each of the treated areas at weekly intervals until October 15. On the dalapon treated area, corn, grain sorghum, and sudangrass failed to emerge following the first date of planting; plants emerged but injury was evident after the second planting; the third and succeeding plantings produced normal emergence and growth by all three crops. Soybeans were severely injured following the first six dates of planting and made unsatisfactory emergence and growth during the remainder of the season. No crop plants or weeds grew in the erbon treated area during the entire season.

The treated areas were plowed in April, 1958, and oats, alfalfa, corn, and grain sorghum were planted across both the dalapon and erbon treated areas. All of these crops emerged and grew with no apparent injury in the dalapon treated area, but no crop survived where erbon had been applied the previous year. (Contribution of the Kansas Agricultural Experiment Station.)

**Herbicides on Johnsongrass. Bondarenko, D. D.** A field moderately infested with Johnsongrass was plowed on May 20, 1957 and planted to corn on May 27. In non-replicated plots, 8 corn rows wide and 100 feet long, the regrowth Johnsongrass plants were spot treated with HCA (10 ml/gal spray solution) and C-56 (hexachlorocyclopentadiene, 380 ml/gal spray solution) in kerosene. The herbicides were applied with a knapsack sprayer to wet only the crown of each Johnsongrass plant. Corn injury was successfully avoided. Three applications were made; the first on June 25 when the Johnsongrass plants were 8 to 10 inches high, the others on July 2 and 9 on Johnsongrass sprouts. On October 11, 1957 the plots indicated 95 to 98 percent kill of Johnsongrass with no difference between herbicides.

In another experiment triplicate plots ½ rod by 1 rod densely infested with Johnsongrass, 8 to 10 inches tall or plowed May 17, were treated with simazin at 5, 10, 15 and 20 lb/A in 80 gpa water on May 18, 1957. The plowed plots were disked 3 times on June 11 and planted immediately to corn (hybrid K-62). The corn was not damaged by the simazin. On October 15, 1957 none of the treated plots indicated a reduction in stand of Johnsongrass. The plots were left undisturbed in 1958. On August 1, 1958 the plots in which simazin at 20 lb/A was applied to nonplowed plots in 1957 showed a 10 to 20 percent reduction in stand of Johnsongrass. There was no reduction in stand of Johnsongrass in the other plots. (The Ohio Agricultural Experiment Station).

**Effectiveness of EPTC in pre-emergence treatments for Johnsongrass seedling control. Freeman, J. F.** In a Johnsongrass control program where rootstocks are being destroyed it is generally recognized that the presence in the soil of dormant Johnsongrass seed is the chief obstacle to complete eradication of the weed. EPTC appeared so promising in preliminary trials in 1957 that additional tests with it were made. Johnsongrass seed was drilled in paired rows at depths of 1, 2, and 3 inches on Burgin silt loam soil on 8/13/58. Two days later main plots were sprayed broadcast with EPTC at 0, 3, 4.5 and 6 lb/A in 32 gal/A of water. Sub-plots were paired rows of each of the 3 planting depths with EPTC incorporated in the soil for one row of each pair and left undisturbed for the other. Incorporation was done at once by chopping the soil 2 to 3 inches deep. Treatments were triplicated. The number of emerged seedling plants per 8.5' length of row was determined on 9/9/58. For main plots the average number of seedlings per row resulting from use of 0, 3, 4.5, and 6 lb/A of EPTC were 59, 4.6, 0.7, and 0.3 respectively. In the untreated plot the number of emerged plants from seed planted 3" deep was only ⅓ as great as that planted 1" or 2" deep, and the number where the soil was chopped was slightly less in each instance than where the soil was undisturbed. In general incorporation of EPTC with the soil resulted in improved performance, the improvement being more pronounced in the lightest rate of treatment and for the shallower depths of planting. Corn planted in the sprayed soil immediately after treatments were made came up to good stands but cutworm injury was such that stand data were not obtained. (Agronomy Department, Kentucky Agricultural Experiment Station)

**Rhizome sprouting as a measure of Johnsongrass control. Ingle, M., and Rogers, B. J.** Johnsongrass (along the Wabash River just south of Terre Haute, Ind.) which varied from 1 to 4 feet in height was sprayed with dalapon (10 and 20 lb/A in 200 gpa of water), HCA (140 lb/A in 200 gpa of water and 100 gpa of kerosene), and 2-methoxy-4,6-bis(isopropylamino)-*s*-triazine (Geigy 31435) (20 lb/A in 220 gpa of water). (The triazine treatment was made by Mr. E. O. Schneider of the Geigy Chemical Corp.) Two weeks after the applications were made rhizomes were dug, cut into one-node sections, and placed in flasks in moist vermiculite at a temperature of 80°F. After 10 days the sprouts were counted. Data are given below:

| Chemical | Rate | Buds sprouting percent of check |
|---|---|---|
| Dalapon | 10 lb/A | 25 |
| | 20 | 60 |
| HCA | 140 | 80 |
| Triazine | 20 | 80 |

[1] The topics of these reports are in the same order as the Research Summaries, pages 46 to 81. Within each topic, the reports are alphabetical by authors. Many reports could be classified under more than one topic, so the classification is sometimes somewhat arbitrary. All are indexed.



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Dalapon at 20 lb and the HCA and triazine caused a rapid contact burn and severe damage to the leaves. It is possible that this interfered with translocation of herbicide into the rhizomes. (Department of Botany and Plant Pathology, Agricultural Experiment Station, Purdue University)

**Spot treatment of Johnsongrass in irrigated sorghum. Wiese, A. F. and Rea, H. E.** In 1957, a 15 percent stand of Johnsongrass in irrigated sorghum was spot treated with 2 gallons of HCA in 100 gal of naphtha, 2 quarts of hexachlorocyclopentadiene (C-56) in 100 gal of diesel oil and 0.74 pound of dalapon in 5 gal of water. The plot size was 300 square feet and the experimental design was a randomized block with 3 replications. Each plot was separated by an untreated check plot. The oils were applied 3 times and the dalapon 4 times during the season.

All treatments eliminated the Johnsongrass. The total cost per acre using one dollar per hour as labor cost was approximately 39, 18 and 19 dollars, respectively, for the HCA, C-56 and dalapon. (Contribution of the Southwestern Great Plains Field Station, Bushland Texas, Texas Agricultural Experiment Station and USDA cooperating.) (Approved as TAES T.A. 3048.)

## QUACKGRASS

**Simazin, dalapon, and amitrol on quackgrass. Bondarenko, D. D.** Duplicate plots ½ rod by 2 rods infested with quackgrass 8 to 10 inches high were treated with simazin, dalapon and amitrol at 10 and 20 lb/A in 40 gpa water on October 1, 1957. The plots were plowed on May 13, 1958 and planted to corn (hybrid W-64) on May 22. On August 15 the plots treated with simazin at 10 and 20 lb/A, dalapon at 20 lb/A and amitrol at 20 lb/A showed a 100 percent reduction in stand of quackgrass. Dalapon at 10 lb/A showed 95 to 100 percent kill of quackgrass. The corn was injured slightly in one plot treated with simazin at 20 lb/A. None of the other treatments injured the corn. In another experiment a dense infestation of quackgrass 6 to 8 inches high was plowed on April 23, 1958. Duplicate plots 1 rod by 2 rods were treated with dalapon at 5 and 10 lb/A, TCA at 5 and 10 lb/A and dalapon plus amitrol at 4 + 2 lb/A on April 29 (to soil), May 13 (quack 1-6 inches high) and May 20 (quack 5-8 inches high.) All herbicides were applied in 40 gpa water. The plots were disked three times on May 26, dragged with a springtooth harrow on July 6 and planted immediately to corn (hybrid W-64). The corn was damaged slightly in the plots that were treated with dalapon at 10 lb/A on May 20. No other treatment damaged the corn. On August 15 the plots treated with dalapon at 10 lb/A on May 20 showed a 70 percent reduction in stand of quackgrass. The other treatments reduced the stand of quackgrass little or none. (The Ohio Agricultural Experiment Station)

**Comparative effect of fenuron and monuron when applied to undisturbed couchgrass. Carder, A. C.** Fenuron and monuron were applied to undisturbed couchgrass sod in the spring of 1953 at the rates indicated in the table to quadruplicate plots. The chemicals were knapsack sprayed in aqueous solution at the rate of 80 gal/A. The grass was a foot high and in shot-blade when treated.

| | Lb/A | Percent survival and re-establishment* of couchgrass after, years | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Fenuron at | 20 | 28 | 82 | 98 | 100 | 100 |
| | 40 | 7 | 10 | 23 | 75 | 93 |
| | 80 | 2 | 0.5 | 0 | 6 | 18 |
| | 100 | 1 | 0 | 0 | 5 | 14 |
| Monuron at | 40 | 6 | 9 | 12 | 29 | 24 |

* Arbitrary estimates by same appraiser.

Eighty lb/A of fenuron were needed to eradicate couchgrass and 3 years were required for the process. However, on the fourth year the residual effect of the chemical had diminished to such an extent that the weed began to invade from surrounding areas. At 40 lb/A of fenuron, elimination was approached one year after treatment, but recovery set in thereafter so that by the fifth year re-establishment was over 90% complete. At 20 lb/A, this chemical gave only partial kill of couchgrass with rapid recovery after the first year. The long-lasting residual effect of monuron is indicated. Although the degree of kill from monuron was not much different from that of fenuron at the same rate, much slower recovery of the couchgrass has occurred. (Contribution of Experimental Farm, Beaverlodge, Alberta).

**Treatment of couchgrass with monuron alone and combined with tillage. Carder, A. C.** Couchgrass sod on shallow black clay loam soil was treated in late spring and early fall of 1952 with monuron. Treatments were made after about 20 in of leaf growth were mowed and raked off. The chemical was knapsack sprayed in aqueous solution at the rate of 80 gal/A. Procedure and results (av. duplicate plots) are given in the table.

| Treatment | Lb/A | Percent survival and re-establishment* of couchgrass after, years | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Spring treatment | | | | | | Fall treatment | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| Monuron on undisturbed sod | 10 | 15 | 8 | 12 | 8 | 15 | 23 | 12 | 5 | 7 | 11 | 22 | 28 |
| | 20 | 5 | 0 | 2 | 2 | 8 | 14 | 4 | 2 | 0 | 2 | 12 | 14 |
| | 40 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 11 | 12 |
| | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Monuron applied, one-wayed 5 in. deep 2 weeks later | 10 | 18 | 40 | 48 | 62 | 80 | 50 | 65 | 32 | 38 | 42 | 48 | 36 |
| | 20 | 10 | 6 | 6 | 8 | 15 | 11 | 18 | 14 | 10 | 8 | 8 | 14 |
| | 40 | 5 | 0 | 0 | 0 | 4 | 3 | 12 | 6 | 5 | 5 | 6 | 11 |
| | 80 | 1 | 0 | 0 | 0 | 1 | 1 | 4 | 0 | 0 | 0 | 1 | 2 |
| One-wayed once 5 in. deep, monuron applied | 10 | 28 | 48 | 35 | 82 | 82 | 60 | 40 | 48 | 55 | 75 | 80 | 63 |
| | 20 | 15 | 5 | 2 | 2 | 11 | 13 | 32 | 15 | 7 | 10 | 11 | 19 |
| | 40 | 8 | 1 | 0 | 0 | 2 | 3 | 15 | 1 | 0 | 0 | 6 | 5 |
| | 80 | 2 | 0 | 0 | 0 | 2 | 2 | 12 | 0 | 0 | 0 | 1 | 1 |
| One-wayed once 5 in. deep, monuron applied, one-wayed again immediately | 10 | 15 | 25 | 20 | 32 | 41 | 33 | 40 | 35 | 38 | 48 | 60 | 45 |
| | 20 | 12 | 8 | 5 | 6 | 11 | 23 | 28 | 22 | 25 | 25 | 27 | 30 |
| | 40 | 5 | 0 | 0 | 0 | 3 | 2 | 25 | 14 | 11 | 15 | 11 | 16 |
| | 80 | 1 | 0 | 0 | 0 | 2 | 1 | 16 | 8 | 6 | 8 | 6 | 9 |

* Arbitrary estimates by same appraiser.

Monuron was most effective when applied in the spring on undisturbed sod. Applied thus, as little as 20 lb/A eradicated the couch, but when tillage was involved this rate did not result in complete kill. Where 40 lb/A or more were applied in the spring on undisturbed sod, couchgrass has not reappeared after 6 years, while in every instance where cultivation was involved the weed has re-established itself before this time by invasion from surrounding untreated areas. Fall treatments were generally less effective than those made in the spring. The data stress the long-lasting residual effective of monuron. Even at the rate of 10 lb/A and where only partial kills were obtained, the couchgrass has been very slow to fill in. Wheat, oats, barley, flax and peas, planted 6 years after application of the 40 lb/A rate produced no worthwhile crop. Flax and peas showed somewhat more tolerance to monuron than the grass cereals. (Contribution of Experimental Farm, Beaverlodge, Alberta.)

**Use of dalapon combined with tillage for the control of couchgrass. Carder, A. C.** On June 4, when a continuous infestation of couchgrass was 8 in. high, dalapon was applied at 6, 8, 8, 10, and 12 lb/A. The chemical was delivered from a boom plot sprayer using 20 gal/A of water. Plots were 2 sq rods in size and quadruplicated. Appraisal 3 weeks later (June 26) showed the following top-growth kills: 6 lb/A, 26%; 8 lb/A, 30%; 8 lb/A, 30%; 10 lb/A, 35%; and 12 lb/A, 41%. Following this appraisal, the entire test was double one-wayed disced crosswise. Weather was hot and dry throughout July and resprouting of the couchgrass was scant and slow. On August 7, 6 weeks from time of tillage when couchgrass resprouts were 4 in high, a second application of dalapon was made. Rates this time were 6, 4, 8, 5, and



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6 lb/A and they were applied, respectively, to those plots receiving the initial 6, 8, 8, 10, and 12 lb/A rates. There was not sufficient growth following this treatment to permit adequate appraisal. The area was given further double one-wayings 2 weeks (August 20) and 8 weeks (October 2) after this chemical treatment. Final results will not be known until 1959. (Contribution of Experimental Farm, Beaverlodge, Alberta).

**Repeated low rates of dalapon for couchgrass control. Carder, A. C.** This experiment consisted of two parts: one where the dalapon was applied to the couchgrass at approximately 10-day intervals; the other where it was applied at approximately monthly intervals. The initial applications in both experiments were made in early summer to a continuous stand of couchgrass 10-12 in high. The chemical was applied to duplicate plots by boom plot sprayer using an aqueous solution at the rate of 60 gal/A. Procedure and results are described in the table.

| Dates applied 1957 | Lb/A active dalapon | Percent topgrowth still living* Sept. 20, 1957 | Percent survival and recovery* June 24, 1958 |
|---|---|---|---|
| June 17, 26, July 6, 15, 22, Aug. 6, 21. | 1 | 10.0 | 72 |
| | 2 | 3.5 | 40 |
| | 3 | 2.5 | 30 |
| June 17, July 15, Aug. 21 | 3 | 2.5 | 40 |
| | 4 | 2.0 | 35 |

* Arbitrary estimates.

Plant kill appraisals made the year following treatment indicate that 3 lb/A applied 7 times at 10-day intervals gave the best control but that this was far from satisfactory. The same rate applied 3 times at monthly intervals proved almost as good as this treatment and was equal to 2 lb/A applied 7 times at 10-day intervals. The 1 lb/A rate applied 7 times at 10-day intervals gave very poor kill. Results suggest that low rates of dalapon repeated many times are little if any more effective than slightly higher rates repeated less frequently. (Contribution of Experimental Farm, Beaverlodge, Alberta).

**Results on couchgrass the year after application of amitrol, dalapon and TCA. Corns, Wm. G.** The 1957 Research Report (p. 40) refers to treatments in this test involving the three chemicals applied in July 1957 on foliage or soil before or after cultivation of sod that year. The table shows the numbers of live shoots per sq yd in mid-June 1958.

| | Application, lb/A | | | | | | |
|---|---|---|---|---|---|---|---|
| | Check | Dalapon | | TCA | | Amitrol | |
| Treatment | 0 + tillage | 30 | 50 | 60 | 100 | 15 | 30 |
| Foliage spray in 1957 | | | | | | | |
| Tillage in July 57, May 58: | 311 | 27 | 12 | 12 | 3 | 171 | 243 |
| Aug. 57, May 58: | 558 | 356 | 166 | 101 | 146 | 134 | 94 |
| July 57, Aug. 57 (3x), May 58: | 203 | — | — | — | — | 126 | 145 |
| May 58 only | 914 | 491 | 518 | 356 | 455 | 468 | 142 |
| Soil spray in 1957 | | | | | | | |
| Tillage in July 57, Aug. 57, May 58: | 85 | 65 | 5 | 6 | 1 | — | — |
| July 57, Aug. 57 (3x), May 58: | 85 | — | — | — | — | 50 | 14 |
| May 58 only: | 351 | 16 | 24 | 47 | 10 | 414 | 179 |

The results are in favor of TCA either as a foliage or a soil treatment plus cultivation, contrary to the 1957 observations favoring dalapon. A similar test begun in spring 1958 shows superiority of TCA during the year when moderate rains after application of chemicals were followed by rather dry weather. Creeping red fescue seeded in May 1958 on all plots treated in 1957 developed normally. (Division of Crop Ecology, Department of Plant Science, University of Alberta.).

**Trials with FB-2, fenuron, and simazin on couchgrass. Corns, Wm. G.** Plots of dense couchgrass sod 100 sq ft in size were treated with 1:1'-ethylene-2:2'-bipyridinium dibromide (FB-2) as follows: 1. June 10, 4 lb/A in 100 gal water, no second treatment. 2. July 2, second applications of 4 lb/A, no third treatment. 3. July 19, third application of 4 lb/A to foliage of certain plots. Shortly after treatments there was browning of the foliage but the grass appeared to have recovered completely by mid-August. Solutions of fenuron pellets at 4 and 6 lb/A dissolved in 100 gal/A water were sprayed on foliage of other plots on June 11. Some leaf-tip necrosis occurred but no apparent major effect was noticeable by mid-September. In another test simazin (granular) was applied dry on June 11, at 10 and 20 lb/A. No appreciable injury to the couchgrass was evident by September 15. There was moderate rainfall following the treatments but the summer was, in general, dry. (Division of Crop Ecology, Department of Plant Science, University of Alberta.)

**Various crops planted at four dates following treatment with dalapon at different dosages for couchgrass control. Friesen, H. A.** Dalapon at rates of 5, 10, 15, 20, and 30 lb/A was applied to actively growing couchgrass (6-8 inches tall) on May 14, 1958. On May 23, after the couch had begun to turn brown, the plots were rototilled and immediately planted to Canus potatoes, Spancross corn, turnips, Redwing flax and Lincoln peas. Further plantings of these crops were made on May 31, June 6 and June 13. Almost complete prevention of regrowth of couch was achieved through the growing season on plots treated with 20 and 30 lb/A of dalapon. Regrowth on the 15 and 10 lb/A plots was 40 and 60%, respectively. Regrowth on the 5 lb/A treatment was nearly complete. Potatoes and turnips were unaffected in stand or yield at all rates and seeding dates tested. Corn was reduced in stand by the 20 and 30 lb/A dosages, but only at the first two planting dates. Peas were severely injured by dosages of 10 lb/A and up at each of the first 3 planting dates. Flax was severely damaged by all treatments at dates 1 and 2 and by the 20 and 30 lb/A dosages at date 3. None of the crops were injured at Date 4 but this seeding date was too late to permit good growth and maturity. (Contributed by the Experimental Farm, Lacombe, Alberta)

**Amitrol for couchgrass control, 1958. Selleck, G. W.** Treatments of amitrol were applied with a variable rate sprayer at an initial rate of 20 lb/A in 35 gal water to plots 15 x 135 ft. The treatments were in combination with mowing and tillage and were initiated on couch and native grasses on sandy-loam soil near Saskatoon, May, 1957. The amount of herbicide (lb/A) necessary to provide 99% control in various treatments is listed in the following table.

| Treatment | | Rate required for 99% control lb/A |
|---|---|---|
| 1957 | 1958 | |
| Mow, spray | 2 Spray | 10 |
| Mow, spray, disk | No treatment | 20 |
| Mow, spray, disk, spray | 1 Spray | 10 |
| Mow, spray, disk, spray | No treatment | 20 |
| Mow, 2 spray, 2 diskings | 1 Spray | 12 |
| Mow, 2 spray, 2 diskings | 3 Diskings | * |
| Spray July 29 | 1 Spray | 7 |
| Spray May 16 | 2 Spray | 8 |
| Spray, disk | No treatment | 11 |
| Spray, disk, spray | No treatment | 13 |
| 3 Spray +3 diskings | 2 Spray | 7 |
| 3 Spray +3 diskings | 3 Diskings | * |
| Spray July 8 | 2 Spray | 8 |

* Whole plot black.

One application of amitrol in 1957 followed by another in 1958 provided results equivalent to any of the others. (Contribution from the Dept. of Plant Ecology, University of Saskatchewan, with financial assistance from Amchem Products, Inc.)

**Amitrol and TBA for couchgrass control, 1958. Sel-**

**leck, G. W.** Amitrol and TBA at initial rates of 20 lb/A were applied in 35 gal water with a variable rate sprayer to duplicate 15 x 135 ft plots July 5, 1957, on silty clay loam soil near Saskatoon. Treatments (which were combined with mowing and tillage) were continued during 1958. The rate of application of herbicides (lb/A) necessary to provide various degrees of control in 1957 and 1958 are presented below.

| Treatment | | Percent control | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1957 | | | 1958 | | |
| | | 99 | 95 | 75 | 100 | 95 | 75 |
| 1957 | 1958 | Application, lb/A, to effect above percent control | | | | | |
| Amitrol once | | * | * | * | .. | .. | .. |
| Amitrol, cult. | 2 Amitrol | * | * | * | 16 | 15 | 13 |
| Amitrol, cult., amitrol | 2 Amitrol | .. | 3 | .. | 13 | 11 | .. |
| Amitrol, cult., amitrol | 3 Cult. | .. | 3 | .. | 0.4 | .. | .. |
| Amitrol, TBA on regrowth | 3 Cult | 6 | .. | 3 | 0.4 | .. | .. |
| Mowed, TBA twice | 2 TBA | .. | .. | 10 | .. | 19 | .. |
| Mowed, amitrol | Amitrol | 18 | 7 | .. | * | * | * |
| Mowed, amitrol, cult. | 2 Amitrol | 4 | 2 | .. | 15 | 13 | 7 |
| Mowed, amitrol, cult. | 2 Cult. | 4 | 2 | .. | 0.4 | .. | .. |
| Mowed, amitrol twice | 2 Amitrol | 4 | 1 | .. | 6 | 5 | 4 |
| Mowed, TBA | 2 TBA | * | * | * | .. | 14 | 10 |

* Control less than 75% at heaviest rate.

Two applications of herbicide or three cultivations in 1958 were necessary to provide 100% control of couchgrass regardless of the intensity of treatments during 1957. Somewhat better results were obtained when couchgrass was mowed and the spray applied to the re-growth. (Contribution from the Department of Plant Ecology, University of Saskatchewan.)

**Dalapon and TCA on couch and brome grasses in spruce trees. Selleck, G. W.** The sodium salt of dalapon at rates of 10, 20, 40 and 80 lb/A and TCA at 60 lb/A were applied to couch and brome grasses in 100 sq ft duplicated plots on silty clay loam soil June 6, 1956. The grasses were 18 in high and in the boot stage. The edges of the plots varied between 2 ft and 5 ft from trunks of spruce trees and the branches often extended over the plots. Dalapon at 40 lb/A was applied adjacent to and around one tree. Second and third treatments at similar rates were applied May 28 and August 22, 1957 to all plots with the exception of the 80 lb/A rate of dalapon, which received its second treatment August 15. On July 18, 1958, more than 95% control was obtained in all plots. Very slight regrowth of grass has occurred between July and September. Needle damage to spruce was observed only where dalapon was applied at 40 lb/A adjacent to the tree. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

## LEAFY SPURGE

**Application of anhydrous borax. Best, K. F. and B. J. LeGrand.** Experience over the past three years has indicated that an application of anhydrous borax (Concentrated Borascu) on leafy spurge produces better results if trash cover is retained, contrary to the instructions which appear on the bag. In the Agricultural Representative District No. 9, the policy is to never clear the trash from a leafy spurge area that a man can walk through. Where leafy spurge is being treated on steep slopes, the chemical is raked into the ground following application. (Canada Department of Agriculture, Experimental Farm, and Saskatchewan Department of Agriculture, Agricultural Representative Service, Swift Current, Saskatchewan.)

**Treatment of leafy spurge in small patches. Best, K. F. and B. J. LeGrand.** Treatment of small patches of leafy spurge with anhydrous borax (Concentrated Borascu) at 4 pounds per 100 square feet along with follow-up spot treatment by 2,4-D on any regrowth, has given excellent eradication on all types of soil, including aikali. The one exception was on a gumbo-type soil at Beaver Flats. This work was carried out in the Agricultural Representative District No. 9 covering some 11 municipalities, and the program is now in the third year. (Canada Department of Agriculture, Experimental Farm and Saskatchewan Department of Agriculture, Agricultural Representative Service, Swift Current, Saskatchewan.)

**Amitrol and the butoxy-ethanol ester of 2,4-D for control of leafy spurge on non-crop land. Brown, D. A.** Plots were laid down in May 1958 on an area heavily infested with this weed. Amitrol at 4, 7, and 10 lb/A was applied as a single treatment at seeding stage, and at similar rates to 6 inch re-growth after mowing at full bloom stage. PBA was applied as a single treatment at 5, 10, 20, and 40 lb/A when the spurge was in full bloom. The 2,4-D(butoxy-ethanol ester) was applied at 2, 4, and 6 lb/A at full bloom and half of each plot was cultivated one month after treatment. The end of the growing season showed almost a complete kill of stems and roots by PBA at the 40 lb/A rate. At the 20 lb rate all aerial growth was killed and most of the roots to a 3 inch depth. At the 5 and 10 lb rate, PBA killed back aerial growth but re-growth was common from healthy roots. Amitrol applied at seeding stage killed aerial growth at all rates but roots remained healthy and re-growth was apparent, particularly at the lower rates. Treating re-growth after mowing with amitrol did not show impressive control. Stems bleached white but roots to the extent of 77 percent showed re-growth. The 2,4-D ester effectively killed aerial growth but re-growth at all rates was 100 percent by August 20. A set of plots was mowed at bloom stage and cultivated twice thereafter. Re-growth was 100 percent at the end of the season. The same condition obtained on plots tilled frequently from late May till August. Leafy spurge gave every evidence that chemical control can only be achieved by excessively heavy rates of PBA. (Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba.)

**The effectiveness of post-harvest applictions of TBA, amitrol, simazin and silvex for eliminating leafy spurge. Derscheid, Lyle A.** Triplicate 1-rd x 5-rd plots of oats were sprayed with ⅓ lb/A of butoxyethanol ester of 2,4-D May 30, 1957 when oats was in 5-leaf stage and spurge was 10 to 14 inches tall, sprayed on August 21, 1957 after harvest with several chemicals and plowed September 4, 1957. The August 21 treatments and the percentage kill of spurge (determined by counts made May 18, 1957 and May 17, 1958) are as follows: amitrol 4, 6, and 8 lb/A—6, 77, and 60% kill; 2,3,6-TBA 1, 2, and 4 lb/A—69, 83, and 74%; X-TBA (ACP-M-103A) 2, 4, and 6 lb/A—79, 73, and 79%; X-TBA (ACP-M-177) 2, 4 and 6 lb/A—70, 75 and 70%; simazin 2, 4, and 8 lb/A—59, 49, and 47%; silvex 10 lb/A—82%. Residual effect of the two higher rates of simazin killed oats planted in 1958 after the corn stalks had been disked to prepare a seedbed. (Contribution of the Agronomy Department, South Dakota State College, Brookings, South Dakota).

**The effectiveness of spring applications of TBA, amitrol, silvex and simazin ahead of corn for eliminating leafy spurge. Derscheid, Lyle A.** Duplicate 1-rd x 5-rd plots of leafy spurge were fall plowed in 1956, sprayed May 16, 1957, when spurge was 8 to 12 inches tall, duckfoot cultivated and planted to corn May 28, 1957. The corn was sprayed with ⅓ lb/A butoxyethanol ester of 2,4-D June 26 and cultivated three times. The May 16 treatments and percentage elimination of spurge( determined by counts made on May 18, 1957 and May 17, 1958) are as follows: amitrol 4, 6, and 8 lb/A—69, 55, and 20%; 2,3,6-TBA 1, 2, and 4 lb/A—55, 37, and 76%; X-TBA (ACP-M-103A) 2, 4, and 6 lb/A—76, 57, and 54%; X-TBA (ACP-M-177) 2, 4, and 6 lb/A—36, 25, and 4%; simazin 2, 4, and 6 lb/—17, 12, and 43%; silvex 10 and 20 lb/A allowed stand of spurge to increase. All



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treatments were applied in 10 gallons of spray solution per acre except simazin, which was applied in 15 gallons. Amitrol and 2,3,6-TBA have given better results in previous experiments when treatments were applied to grain stubble and spring plowing was used instead of the duckfoot cultivating used in this experiment. Silvex at 20 lb/A was the only treatment that injured the corn. (Contribution of the Agronomy Department, South Dakota State College, Brookings, South Dakota).

**The effect of early spring treatment on leafy spurge and field bindweed using various chemicals. Krejci, Allan E.** Triplicate square rod plots of leafy spurge in a pasture in Northeastern Nebraska were treated on April 9, 1957 when the spurge was 2-4 inches tall. Two to three inches of snow fell that evening. A uniform stand of field bindweed emerged in the same area approximately three weeks after treatment. Following is a list of treatments and the estimated percent control on Sept. 29, 1958. Erbon at 1 lb/sq rd gave 85% control of leafy spurge but poor control of field bindweed. A polychlorobenzoic formulation containing 80% trichlorobenzoic acid applied at 40 lb/A showed 85% control on leafy spurge and 98% control on field bindweed. Anhydrous sodium borate (Concentrated Borascu) at 16 lb/sq rd gave 65% control on leafy spurge and 80% control on field bindweed. A BDM (D.B. Granular) at 6 lb/sq rd showed 85% control on leafy spurge but poor control on field bindweed. AMS (Ammate X) applied at 5 lb/sq rd gave poor control on both leafy spurge and field bindweed. 2,3,6-trichlorobenzoic acid at 40 lb/A gave only fair control, 50% or less, on leafy spurge but 90% control on field bindweed. Polychlorobenzoic acid at 40 lb/A gave only fair control, 50% or less on leafy spurge but 98% control on field bindweed. Of these chemicals and rates used only AMS proved entirely unsatisfactory. Concentrated Borascu and the benzoic acid formulations at the rates used gave only fair control of leafy spurge; however, they gave satisfactory to good control of field bindweed. Erbon and D. B. Granular gave poor results on field bindweed but looked satisfactory on leafy spurge. (Contribution of the Weed Division, Department of Agriculture and Inspection, Lincoln, Nebraska.)

**Control of leafy spurge with chlorinated benzoic acid. Sand, Paul F. and Shafer, N. E.** Triplicate square rod plots were established in a native grass pasture at Lincoln, Nebraska that was heavily infested with leafy spurge. Stem counts were made from forty square feet in each plot in a permanently marked area. Counts before treatment were made June 20, 1957 and after treatment on October 7, 1958. The dates of application of chemicals were June 25, 1957 and November 12, 1957. Anhydrous sodium borate (Concentrated Borascu) was applied December 2, 1957. Rates and chemicals used were ACP 177 which consisted mainly of 52.3% 2,3,5-trichlorobenzoic acid and 19.1% 2,3,6-trichlorobenzoic acid; Benzac 103, which consisted mainly of 36.9% 2,3,5,6-tetrachloro, 17.2% 2,3,4,5-tetrachloro, 16.0% 2,3,5-trichloro and 7.6% 2,3,6-trichlorobenzoic acid; Hooker X33 which had the same active ingredients as Benzac 103; Hooker X80, which had the same active ingredients as ACP 177; the sodium salt of 2,3,6-trichlorobenzoic acid; an oil soluble formulation of 2,3,6-trichlorobenzoic acid; all at 32, 48 and 64 lb/A: and Concentrated Borascu at 12 lb/sq rd. There appeared to be little or no difference between the various formulations of chemicals. The polychlorobenzoic acids gave results equal to those of the 2,3,6-trichlorobenzoic acid. There was also no difference between the oil soluble formulation of 2,3,6 TBA and the sodium salt formulation. The 64 lb/A rates were the only rates that approached satisfactory control. Many of the plots that were treated with 64 lb/A in the fall of 1957, regardless of formulation, were completely free of spurge. However, this was not consistent for all replications. A few of the plots treated with 32 and 48 lb/A rates were nearly free of spurge plants but most plots treated with these rates had a sufficient number of plants to necessitate complete retreatment of the entire area. Fall treatments had definitely given better control than spring application at the time stem counts were made. Concentrated Borascu gave good results when applied in the spring. The fall application resulted in poor control. (Contribution of the Department of Agronomy, University of Nebraska, Lincoln, Nebraska.)

**The effect of amino triazole on leafy spurge, 1958. Selleck, G. W.** Amitrol at an initial rate of 20 lb/A in 35 gal of water was applied to leafy spurge in duplicate, 15 x 135 ft plots with a variable rate sprayer on sandy-loam soil near Saskatoon. The treatments commenced in May, 1957 and were combined with mowing and tillage. In 1957, some of the plots were mowed prior to spraying, followed by alternate spraying and tillage as regrowth reappeared. The number of treatments and rate of amitrol (lb/A) required to maintain various percentages of control are given in the following table.

| Treatment | | Percent control | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1957 | | | 1958 | | |
| | | 99 | 95 | 75 | 100 | 95 | 75 |
| 1957 | 1958 | Application, lb/A, to effect above percent control | | | | | |
| Mow, spray | 2 Spray | — | — | 15.0 | 14.2 | 11.0 | — |
| Mow, spray, disk | — | — | — | 15.0 | — | — | — |
| Mow, spray, disk, spray | 1 Spray | — | 10.0 | — | — | — | 11.2 |
| Mow, 2 spray, 2 disk | 1 Spray | — | 15.0 | 8.0 | — | — | 11.2 |
| Mow, 2 spray, 2 disk | 3 Disk | — | 15.0 | 8.0 | * | * | * |
| Mow, spray July 29 | 1 Spray | 13.2 | 7.0 | — | — | 16.4 | 10.0 |
| Spray May 16 | — | 20.0 | — | — | — | — | — |
| Spray, disk | 1 Spray | * | * | * | — | — | 20.0 |
| Spray, disk, spray | 2 Spray | 1 | 1 | 12.0 | 12.0 | 6.0 | — |
| 3 Spray, 3 disk | 3 Disk | 11.5 | 6.5 | — | * | * | * |
| Spray July 9 | 2 Spray | 7.0 | — | 5.0 | 7.7 | — | 7.0 |

* Less than 75% control by the highest rate.

Two applications of amitrol were necessary to control top growth during 1958 regardless of the treatments in 1957. The best results were obtained when a single application of amitrol was applied July, 1957. Mowing in the bud stage prior to the first application of spray appears to assist in control. Leafy spurge was still vigorous on disked plots in August, 1958 and the loose condition of the soil did not justify further tillage. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from Amchem Products, Inc.)

**Leafy spurge control with 2,4-D, 1958. Selleck, G. W.** Several applications of the butyl ester of 2,4-D at an initial rate of 8 lb/A in 35 gal water were applied with a logarithmic sprayer to leafy spurge on sandy loam soil near Saskatoon commencing May, 1957. Applications were repeated when regrowth had reached a height of 2 to 4 in. The experiment was continued during 1958, using both the standard butyl ester and a low volatile ester (ACP 129) of 2,4-D. The treatment and percentage of top growth at various rates (lb/A) for 1957 and 1958 are provided in the following table. In 1957, the assessment was made in the fall, prior to the last application.

| No. applications | | Per cent control | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1957 | | | 1958 | | |
| 1957 | 1958 | 100 | 95 | 75 | 99 | 90 | 75 |
| | | Application, lb/A, to effect above per cent control | | | | | |
| 2 | 3 | * | * | * | * | * | * |
| 2 | 4 | * | * | * | — | 2.5 | 1.4 |
| 3 | 2 | * | | * | 3.2 | — | 0.3 |
| 4 | 4 | 6.7 | 1.1 | 0.7 | 3.9 | — | 0.4 |
| 5 | 4 | 2.4 | — | 0.6 | 3.9 | 1.5 | 0.6 |
| 6 | 4 | — | — | — | 2.6 | 1.0 | 0.4 |

* Control less than 75% at highest rate.

Top growth was killed at all rates between 8 lb and 6 oz/A, but regrowth appeared to be more rapid at the

lighter rates of application. The density of the weed was decreased from 150 to 200 shoots per sq yd to 1 to 2 shoots per sq yd. No differences were apparent in control of leafy spurge by the standard or low volatile esters of 2,4-D. (Contribution from the Department of Plant Ecology, University of Saskatchewan with financial assistance from Amchem Products, Inc.)

**The effect of various herbicides on leafy spurge and toadflax, 1958. Selleck, G. W.** Concentrated Borascu (61.5% $B_2O_3$) at rates of 1, 2, and 4 lb, a BDM (43.2% $B_2O_3$, 7% 2,4-D) at 0.5, 1, and 2 lb, Ureabor (45.4% $B_2O_3$, 4% monuron) at ¼, ½, 1, and 2 lb, Gerstley Borate (33% $B_2O_3$) at 2, 4, and 8 lb/100 sq ft, total product, were applied to toadflax near Hague, Sask. and to leafy spurge near Saskatoon, Sask. on sandy-loam soil. The herbicides were applied to 16 x 100 ft plots with a Gandy spreader on June 11, 1956. The average control of weeds and regrowth of grass, Sept., 1958, (based on visual estimates) is presented below.

| Herbicide | Rate, lb/100 sq ft | Percent control | | Pct. regrowth of grass |
|---|---|---|---|---|
| | | Toadflax | Leafy spurge | |
| Ureabor | ¼ | 0 | 0 | 6 |
| | ½ | 0 | 25 | 1 |
| | 1 | 75 | 60 | 0 |
| | 2 | 99 | 99 | 25 |
| Gerstley Borate | 2 | 100 | 30 | 100 |
| | 4 | 97 | 70 | 92 |
| | 8 | 100 | 99 | 52 |
| Borate-2,4-D | ½ | 80 | 70 | 100 |
| | 1 | 95 | 85 | 100 |
| | 2 | 100 | 99 | 92 |
| Concentrated Borascu | 1 | 100 | 90 | 95 |
| | 2 | 100 | 100 | 82 |
| | 4 | 100 | 99 | 57 |

(Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**The effect of several herbicides on the control of leafy spurge, 1958. Selleck, G. W.** Chlorea (sodium chlorate 40%, sodium metaborate 57%, monuron 1%) at 2 and 4 lb, Concentrated Borascu (61.5% $B_2O_3$) at 2 and 4 lb, C.C. 519 (97% sodium metaborate, 3% monuron) at 2 and 4 lb, C.C. 520 (93% sodium metaborate, 5% MCPA, 2% monuron) at 2 and 4 lb, C.C. 548 (95% sodium metaborate, 5% MCPA) and borate-2,4-D (43.2% $B_2O_3$, 7% 2,4-D) at 1 and 2 lb/100 sq ft were applied to leafy spurge on duplicate, 10 x 10 sq ft plots on sandy-loam soil near Saskatoon Sept. 20, 1956. Ureabor (45.4% $B_2O_3$, 4% monuron) and Ureabor-2,4-D were applied at the same location at rates of ½ and 1 lb/100 sq ft Oct. 19, 1957. The average percentage control of leafy spurge and regrowth of grass (based on visual estimates) taken in the fall of 1957 and 1958 are presented below.

| Herbicide | Rate lb/100 sq ft | Percent control | | Percent regrowth of grass | |
|---|---|---|---|---|---|
| | | 1957 | 1958 | 1957 | 1958 |
| Chlorea | 2 | 97 | 92 | 0 | 0 |
| | 4 | 92 | 75 | 0 | 0 |
| Conc. Borascu | 2 | 55 | 80 | 75 | 100 |
| | 4 | 97 | 99 | 55 | 95 |
| Borate-2,4-D | 1 | 70 | 80 | 100 | 100 |
| | 2 | 99 | 97 | 100 | 100 |
| C.C. 519 | 2 | 98 | 85 | 0 | 0 |
| | 4 | 97 | 100 | 0 | 0 |
| C.C. 520 | 2 | 97 | 95 | 5 | 5 |
| | 4 | 100 | 99 | 0 | 0 |
| C.C. 548 | 2 | 96 | 95 | 75 | 100 |
| | 4 | 100 | 99 | 30 | 100 |

After one year, Ureabor-2,4-D at the 1 lb rate maintained 85% control of leafy spurge, permitting almost complete regrowth of the grass. The mixture was less effective at the ½ lb rate but was superior to results obtained with Ureabor. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**The effect of 2,4-D and borate compounds on regrowth of leafy spurge and toadflax, 1958. Selleck, G. W.** The dimethyl amine salt of 2,4-D at 10 lb/A, Concentrated Borascu (61.5% $B_2O_3$) at 535 lb/A and borate-2,4-D (43.2% $B_2O_3$, 7% 2,4-D) at 259 lb/A were applied in 1956 to regrowth of leafy spurge and toadflax in plots which had been treated with borate compounds in 1955. The 2,4-D did not maintain control of either species after the first year of application, while the borate compounds maintained 99 to 100% control of the toadflax. The control of leafy spurge was poor in 1958. In 1957, 2,4-D butyl ester applied at a rate of 5 lb/A provided 100% control of toadflax seedlings, but the 2.5 lb/A rate provided only about 75% control. Leafy spurge seedlings which appeared in 1958 on plots which were treated with borate compounds in 1955 were marked with stakes and 2,4-D applied with a variable rate sprayer at an initial rate of 8 lb/A in 35 gal water. The seedlings were killed 100% at all rates above 11 oz/A. Some seedlings survived at lower rates of application. Seedlings were staked out on adjacent untreated plots for observation. Only a few of these failed to survive. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from Amchem Products, Inc.)

**The effect of several herbicides on the control of leafy spurge, 1958. Selleck, G. W. and R. T. Coupland.** Chlorea (sodium chlorate 40%, sodium metaborate 57%, monuron 1%) at 50, 100 and 200 lb/A, AMS (Ammate) at 435, 870 and 1305 lb/A, fenuron at 25, 50 and 100 lb/A, monuron and diuron at 50 lb/A total product and erbon at 50, 100 and 150 lb/A active ingredient were applied to leafy spurge on 100 sq ft plots on sandy-loam soil near Saskatoon in June, 1955. The three rates of Ammate maintained 95 to 100% control in 1958 and fenuron at 100 lb/A maintained 90% control. The heavy rate of erbon, the medium and heavy rates of Ammate and all rates of the urea compounds permitted very little regrowth of the grass. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**Further observations of the effect of borate compounds on toadflax and leafy spurge, 1958. Selleck, G. W. and R. T. Coupland.** Numerous 100 sq ft plots of toadflax near Hague, Sask and leafy spurge near Saskatoon, Sask. were treated in 1953 and 1954 with borate compounds on sandy-loam soil. Concentrated Borascu at rates of 3, 4, 5, 6, and 7 lb/100 sq ft and the borate-2,4-D mixture at 1, 2, and 3 lb/100 sq ft maintained 90 to 95% control of leafy spurge, Sept., 1958. In the toadflax plots, 95% control was maintained with Borascu at 1, 2, 3, 5, and 6 lb/100 sq ft, borate-2,4-D at 2 and 3 lb/100 sq ft and Polybor-chlorate at 1, 1.5, 2, and 2.5 lb/sq ft. The stand of grass in the treated plots was in most cases superior to that which occurred in the checks. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**The effect of borate compounds on leafy spurge and toadflax, 1958. Selleck, G. W. and R. T. Coupland.** Concentrated Borascu (61.5% $B_2O_3$) at rates of 1, 2 and 4 lb and a BDM (43.2% $B_2O_3$, 7% 2,4-D) at ½, 1 and 2 lb of total product per 100 sq ft were applied on 16 x 100 ft plots in May and Sept., 1955, to toadflax (black soil zone) near Hague, Sask. and to leafy spurge near Saskatoon (dark brown soil zone) on sandy-loam soil. Similar treatments were made to toadflax and leafy spurge on sandy-loam soil (brown soil zone) near Parkbeg, Sask. The average control of weeds, Sept., 1958, (based upon visual estimates) is presented below.



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| Herbicide | Rate lb/100 sq ft | Pct. control | |
|---|---|---|---|
| | | Toadflax | Leafy spurge |
| Concentrated Borascu | 1 | 99 | 93 |
| | 2 | 93 | 94 |
| | 4 | 96 | 99 |
| Borate-2,4-D | ½ | 40 | 52 |
| | 1 | 83 | 93 |
| | 2 | 98 | 99 |

Fall applications maintained better control of both weeds than spring applications. The mean percentage control of toadflax at the 4 lb rate of Concentrated Borascu averaged only 96%. This may be attributed to regrowth of toadflax which was occurring on a portion of one plot where the grass was killed out. On the average, grass was depressed only slightly at the 2 and 4 lb/100 sq ft rates of Concentrated Borascu. Concentrated Borascu and borate-2,4-D were applied to leafy spurge and toadflax just before freeze-up, 1957, and just after the spring thaw, 1958. More complete control of both species was obtained with the fall application. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**Leafy spurge control with several herbicides used as soil sterilants. Sexsmith, J. J.** Over the past few years, several herbicidal materials have been applied to duplicate sq-rd plots in a heavily spurge-infested stand of mixed grasses growing on loam soil near Calgary, Alberta. Four sets of treatments were applied, and the following materials were used on one or more occasions: Na chlorate; CBM (Polybor-chlorate, 74% mixed borates, 25% Na chlorate); anhydrous borax (Conc. Borascu, 89% anhydrous Na tetraborate); BMM (Ureabor, 94% disodium tetraborates, 4% monuron); BDM spray (DB Spray Powder, 90.5% disodium tetraborates, 7.5%, 2,4-D); BDM gran. (DB Granular, same composition as BDM spray); 2,4-D (butyl ester); PBA (Benzac 103A, polychlorobenzoic acid); and simazin. The following summary table presents the control of leafy spurge as estimated on September 11, 1958:

| Material | Rate lb/100 sq ft | Per cent spurge control 9/11/58 Treatment date | | | |
|---|---|---|---|---|---|
| | | 5/10/55 | 10/13/55 | 6/1/56 | 5/16/57 |
| Na chlorate | 2 | 47 | 68 | — | — |
| | 2½ | — | — | 47 | — |
| CBM | 2 | 67 | — | — | — |
| Anhyd. borax | 3 | 79+ | 96 | — | — |
| BMM | ¾ | nil | nil | — | — |
| | 1½ | — | 87 | — | — |
| BDM spray | 1 | — | 78 | — | — |
| | 2 | 85 | — | — | — |
| BDM gran. | 1 | — | 42 | — | — |
| | 2 | 85 | 94 | 97 | 94 |
| | lb/A | | | | |
| 2,4-D | 24 | — | 10+ | — | — |
| | 48 | — | 14 | — | — |
| PBA | 20 | — | — | — | 25+ |
| | 40 | — | — | — | 91 |
| Simazin | 20 | — | — | — | 26 |
| | 40 | — | — | — | 65 |

Sodium chlorate at 2½ lb and CBM at 2 lb/100 sq ft gave incomplete and non-lasting control of spurge and were injurious to grasses. Anhydrous borax at 3 lb/100 sq ft gave reasonably good control of spurge with no prolonged injury to the grasses, as did the 2-lb rate of BDM, spray and granular. BMM at 1½ lb/100 sq ft gave reasonable spurge control but eliminated the grasses. The butyl ester of 2,4-D seemed to give satisfactory control up to one and one-half years after treatment, but control after three years was very poor as a result of recovery and/or reinfestation. The control recorded 16 months after treatment was better for PBA at 40 lb/A than for simazin at the same rate, with only slight injury to grasses as compared with elimination by simazin. It should be mentioned that the rated control for the 40 lb/A simazin treatment on Sept. 11/58 was greater than that recorded on May 14/58, indicating the slow action of simazin and the possibility that the full effects of treatment had not been attained. (Canada Dept. of Agriculture, Experimental Farm, Lethbridge, Alberta.)

## RUSSIAN KNAPWEED

**Treatment of Russian knapweed in small patches. Best, K. F. and B. J. LeGrand.** Anhydrous sodium borate (Concentrated Borascu) at rates of up to 6 lb/100 sq ft has not proven satisfactory for the control of Russian knapweed in Agricultural Representative District No. 9. Indications are that a light application of a CBM (Polybor chlorate) at 1 lb/100 sq ft is as effective as a 4 lb/100 sq ft treatment when the patches are to be retreated at a later date. (Canada Department of Agriculture, Experimental Farm, and Saskatchewan Department of Agriculture, Agricultural Representative Service, Swift Current, Saskatchewan.)

**The effect of herbicides on Russian knapweed. McCurdy, E. V.** Chemicals were applied on June 10, 1958 to plots of Russian knapweed, 10 feet square. Precipitation was very much below normal in this district and this made it difficult to assess results. Some plots where chemicals had not been satisfactory were retreated on July 29. A mixture of chlorinated benzoic and cresoxyacetic acids (CP 1815) at 12 and 24 oz/A was applied at the early date but the results were unsatisfactory. Two other products, 3-(3,4-dichlorophenyl)-1-1-diethylurea at 6 lb/A and simazin at 4 lb/A did not result in any reduction in the number of plants. The dimethylamine salt of trichlorobenzoic acid (Tryben 200) at 5 lb/A killed about 50% of the weeds but at 10 lb/A was somewhat more effective. Plots were retreated at 15, 20 and 25 lb/A. At 15 lb/A the kill was incomplete but at 20 and 25 lb/A control was excellent. A rate of 5 lb/A of polychlorinated benzoic acid (Benzac 354) was not heavy enough to kill this weed, at 7.5 lb/A the plants were retarded, and at 10 lb/A regrowth had not occurred but the plants had not dried up. A mixture of borate and sodium chlorate (Polybor chlorate at 3 lb/100 sq ft did not result in 100% control this year. With a BDM (DB Granular) at 3 lb/100 sq ft the action was very slow and by fall the plants could not be considered completely eradicated. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

**The effect of several herbicides applied as soil sterilants for the control of Russian knapweed in Western Nebraska. Nash, R. L. and Wicks, G. A.** 2,3,6-TBA was applied at 20, 40, 60 lb/A on square rod plots at Lexington, Nebraska April 29, 1957. Several herbicides were applied on square rod plots October 20, 1957 at Rushville, Nebraska. They were: DB Granular at 6 and 8 lb/sq rd; sodium chlorate at 6 and 8 lb/sq rd; Conc. Borascu at 15 and 18 lb/sq rd; Novon at 80 and 160 lb/A; amine of polychlorobenzoic acid at 16, 32, and 48 lb/A; polychlorbenzoic acid (80% TBA) at 16, 32 and 48 lb/A; polychlorbenzoic acid at 16, 32, and 48 lb/A; 2,3,6-trichlorobenzoic acid at 16, 32, and 48 lb/A; simazin at 20 and 40 lb/A; silvex at 40, 60, and 80 lb/A; and ONCB at 150 and 200 lb/A. The Russian knapweed at Rushville had been one-wayed previous to application of the chemicals. Estimations of control were made in October of 1958. The treatments at Lexington all gave excellent control. The treatments at Rushville were as follows: DB Granular at 8 lb/sq rd; amine of polychlorobezoic acid at 48 lb/A; polychlorobenzoic acid (80% TBA) at 16, 32, and 48 lb/A; polychlorobenzoic acid at 48 lb/A; and 2,3,6-trichlorobenzoic at 16, 32, and 48 lb/A gave excellent control. Sodium chlorate at 6 and 8 lb/sq rd; Conc. Borascu at 15 and 18 lb/sq rd; erbon at 80 and 160 lb/A; amine of polychlorobenzoic acid at



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16 and 32 lb/A; polychlorobenzoic acid at 32 lb/A gave satisfactory control. The other chemicals did not give satisfactory control. (Contributed by University of Nebraska Experiment Station, North Platte, Nebraska and Nebraska Department of Agriculture and Inspection, Division of Noxious Weeds, Lincoln, Nebraska).

**The effect of borate compounds on Russian knapweed and hoary cress, 1958. Selleck, G. W.** Concentrated Borascu (61.5% $B_2O_3$) at rates of 1, 2 and 4 lb and a complex of borate-2,4-D (43.2% $B_2O_3$ and 7% 2,4-D) at ½, 1 and 2 lb/100 sq ft were applied to globe-podded hoary cress and Russian knapweed on alluvial clay soil at Log Valley and Leader, Sask. The herbicides were applied July, 1956 with a 4-ft Gandy spreader to plots 16 x 100 ft. No control of either species was obtained at Leader in 1958 even with the heaviest rates. The heaviest rates of Concentrated Borascu and borate-2,4-D controlled Russian knapweed 80% and 70% respectively at Log Valley. The hoary cress was not visibly affected. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

## FIELD BINDWEED

**Control of field bindweed with soil applications of herbicides. Nash, R. L. and Wicks, G. A.** A number of chemicals were applied to square-rod plots of field bindweed in April, May, September, October, and November of 1957. This report is a summary of results at seven locations in Western Nebraska. Fifteen chemicals were used. They were: a BDM (DB Granular) at 6 and 8 lb/sq rd; anhydrous sodium borate (Conc. Borascu) at 12, 15, and 18 lb/sq rd; sodium chlorate at 6 and 8 lb/sq rd; a BMM (Ureabor) at 5 and 7 lb/sq rd; AMS at 5 lb/sq rd; a CBMM (Chlorea) at 5 and 7 lb/sq rd; erbon at 80 and 160 lb/A; simazin at 20 and 40 lb/A; potassium salt of MCP (Kalzate A) at 40 lb/A; silvex at 20, 40, 60, and 80 lb/A; amine PBA[a] at 16, 32, and 48 lb/A; PBA (80% TBA) at 16, 32, and 48 lb/; 2,3,6-TBA at 16, 20, 32, 40, 48, and 60 lb/A; PBA[a] at 16, 32 and 48 lb/A; and monuron at 80 lb/A. Those chemicals giving excellent control were: (the number in parenthesis following the chemical is the number of locations at which the chemical was present) DB Granular at 8 lb/sq rd (5); Conc. Borascu at 15 lb/sq rd (4); sodium chlorate at 6 and 8 lb/sq rd (6); Chlorea at 5 and 7 lb/sq rd (1); erbon at 80 and 160 lb/A (1 and 4); Kalzate A at 40 lb/A (1); silvex at 80 lb/A (1); amine PBA at 32 and 48 lb/A (2 and 3); PBA (80% TBA) at 16, 32, 48 lb/A (2, 3, and 5); 2,3,6-TBA at 16, 20, 32, 40, 48, and 60 lb/A (2, 1, 5, 2, 3, and 2); and PBA at 32 and 48 lb/A (2). Those giving satisfactory results were: DB Granular at 6 lb/sq rd (7); Conc. Borascu at 12 and 18 lb/sq rd (2); silvex at 40 and 60 lb/A (3 and 4); amine PBA at 16 lb/A (1); PBA at 16 lb/A (2); and monuron at 80 lb/A (1). The following chemicals gave unsatisfactory control: simazin at 20 and 40 lb/A (1 and 2); silvex at 20 lb/A (1); Ureabor at 5 and 7 lb/sq rd (1); and AMS at 5 lb/sq rd (1). (Contributed by University of Nebraska Experiment Station, North Platte, Nebraska, and Nebraska Department of Agriculture and Inspection, Division of Noxious Weeds, Lincoln, Nebraska.)

[a] Consists of approximately 16.3% 2,3,5-trichlorobenzoic acid, 7.8% 2,3,6-trichlorobenzoic acid, 36.4% 2,3,5,6-tetrachlorobenzoic acid, and 39.5% of other isomers.

**Control of field bindweed with chlorinated benzoic acid. Sand, Paul F. and Shafer, N. E.** Square rod plots were established on field bindweed growing on Sharpsburg silty clay loam at Lincoln, Nebraska. Treatments were applied May 27, 1957, July 16, 1957 and September 27, 1957. Stem counts for control were made before treatment and October 4, 1958. Rates and formulations were: ACP 177 (19.1% 2,3,6-trichlorobenzoic acid, 52.3% 2,3,5-trichlorobenzoic, and lesser amounts of 2,5-dichloro, 2,4,5-trichloro, 2,3,4,5-tetrachloro, and 2,3,5,6-tetrachlorobenzoic acid); ACP 103A (7.6% 2,3,6-trichlorobenzoic acid, 11.4% 2,5-dichlorobenzoic acid, 16.0% 2,3,5-trichlorobenzoic acid, 17.2% 2,3,4,5-tetrachlorobenzoic acid, 36.0% 2,3,5,6-tetrachlorobenzoic acid and lesser amounts of others); the sodium salt of 2,3,6-trichlorobenzoic acid; all at 16, 32, and 48 lb/A; Hooker X-33 which has the same active ingredients as ACP 103A at 48 lb/A and sodium chlorate at 6 lb/sq rd. All chemicals and rates gave excellent control when applied in September of 1957. All but four plots out of the 33 treated at this date were entirely free of bindweed plants on October 4, 1958. The four that were not entirely clean had three or less bindweed stems per plot. May treatments were effective at the 32 and 48 lb/A rates. Most plots at these rates were entirely free from bindweed plants or had one or two stems per plot. More regrowth occurred from the July treatments than from the May treatment. However, the trend from low rates to high rates was the same. There were more plants on plots treated with 16 lb/A than on the plots treated with 32 lb/A. The 2,3,6-trichlorobenzoic acid gave slightly better control at the 16 lb/A rate than ACP 103A and ACP 177 but all three formulations gave unsatisfactory control when applied in May and July at this rate. The 48 lb/A rates of all chemicals gave excellent control. Most plots treated at this rate were entirely free of bindweed regardless of time applied. Sodium chlorate gave good results but best results were obtained by the September treatments. (Contribution of the Department of Agronomy, University of Nebraska, Lincoln, Nebraska.)

**Period of soil residual effects from soil sterilants on Pullman silty clay loam soil. Wiese, A. F. and Rea, H. E.** Applications of anhydrous sodium tetraborate (Concentrated Borascu) at 14, 16, and 18, sodium chlorate at 3, 5, and 7 and monuron at ¼, ⅜, and ½ pounds per square rod, respectively, were made in July and October in 1952 and January and February 1953. Monuron, sodium chlorate, anhydrous sodium tetraborate, and a CBM (sodium pentaborate, 58%, sodium tetraborate, 15%, and sodium chlorate, 25%) (Polybor Chlorate) at ¼, 6, 18, and 10 pounds per square rod, respectively, were applied in September 1953. Plantings of sorghum made in 1956 and 1957 indicate that after 5 years sodium chlorate up to 6, and monuron at ¼ pound per square rod did not injure sorghum. Sodium chlorate at 7 and monuron at ⅜ and ½ and CBM at 10 pounds per square rod, respectively, allowed some crop growth, but sodium tetraborate completely inhibited sorghum growth. Total rain for the 5 year period was only 70 inches.

Another soil sterilant study which was started in 1953 received approximately 10 inches of irrigation water annually in addition to rainfall in 1953, 1954 and 1955. No irrigation was applied in 1956 or 1957. Sorghum yields in 1957, from the check, sodium chlorate at 6, monuron at ½, CBM at 10 and anhydrous sodium tetraborate at 18 pounds per square rod were 954, 1187, 1677, 774 and 542 pounds per acre, respectively. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agricultural Experiment Station and USDA, cooperating.) Approved as TAES. T.A. 3047.

**Effect of subsequent listing on soil sterilizations for controlling bindweed. Wiese, A. F. and Rea, H. E.** Triplicated split plots of Pullman silty clay loam soil infested with bindweed were used in testing the affects of subsequent listing on soil sterilization. Anhydrous sodium tetraborate (Concentrated Borascu) at 16 and sodium chlorate at 5 pounds per square rod were applied in October, 1954 and May, 1955. A 6-inch irrigation was applied to all areas immediately after each soil sterilant application and in July, 1955. Portions of appropriate plots were listed 8 inches deep in June, 1955 and June, 1956. Corresponding portions of the plots were undisturbed. All undisturbed areas and those listed after applying sodium chlorate were free of bindweed on May, 1957. However, bindweed was growing vigorously in the lister furrows in the areas treated with sodium tetraborate. Sorghum grown in samples from the test area showed that sodium chlorate had penetrated the soil to a depth of 24 inches by May, 1957 while sodium tetraborate had penetrated to a depth of only 12 inches. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agricultural Experi-



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ment Station and USDA, cooperating.) Approved as TAES T.A. 3049.

**2,3,6-Trichlorophenylacetic acid for eradication of bindweed and Johnsongrass. Wiese, A. F. and Rea, H. E.** An amine salt and an amide of 2,3,6-trichlorophenylacetic acid were each applied to bindweed and Johnsongrass at the rates of 5, 10, 20, 40 and 80 pounds per acre in August 1957. These treatments were compared to sodium chlorate and monuron at 960 and 60 pounds per acre. Each test was duplicated in a randomized block. One year later the bindweed had been eradicated by all rates of 2,3,6-trichlorophenylacetic acid except the 5 pound treatment of the amine formulation, which gave 80% control, and the 5 and 10 pound rates of the amide which gave 89 and 96 percent control, respectively. The sodium chlorate and monuron controlled 99 and 95 percent of the bindweed, respectively.

The 5, 10, 20, 40 and 80 pound rates of the amine formulation of 2,3,6-trichlorophenylacetic acid controlled 0, 25, 55, 80 and 100 percent of the Johnsongrass, respectively. The same rates of the amide gave 5, 15, 60, 93 and 98 percent control, respectively. The sodium chlorate and the monuron, respectively, controlled 67 and 20 percent of the Johnsongrass. The LSD 5% for the Johnsongrass study was 25 percent. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agricultural Experiment Station and USDA, cooperating.) Approved as TAES T.A. 3046.

**The effect of carrier and method of application on the toxicity of 2,4-D and silvex to bindweed. Wiese, A. F. and Rea, H. E.** Propylene glycol butyl ether esters of silvex and 2,4-D were applied at the rate of 40 pounds per acre broadcast with 240 gallons of water, 40 gallons of water, or 40 gallons of kerosene. Approximately 40 pounds per acre of the chemicals were applied by treating individual bindweed crowns with a mixture of 10 pounds of the chemical in 100 gallons of kerosene. In addition 1 lb/A of silvex and 2,4-D were each applied broadcast in 40 gal/A water. The plot size was 1 square rod and the treatments were replicated 3 times. The plots were located on Pullman silty clay loam soil and received approximately 22 inches of rainfall and irrigation water during the experimental period, May 1957 to May 1958. Silvex applied at 40/A, to the crowns, in 240 gal/A of water, in 40 gal/A of water, and in 40 gal/A of kerosene gave 100, 99, 97, and 92 percent control, respectively. Forty pounds per acre of 2,4-D applied by the same methods gave 41, 90, 95, and 57 percent control. The one lb/A rates of silvex and 2,4-D gave 31 and 77 percent control, respectively. The LSD 5% was 19 percent. Applying the materials to the bindweed crowns took about 5 times as long as broadcasting the material over the entire area. (Contribution of the Southwestern Great Plain Field Station, Bushland, Texas, Texas Agricultural Experiment Station and USDA, cooperating.) Approved as TAES T.A. 3052

**Soil sterilization for bindweed control on sandy soil in Northwest Texas. Wiese, A. F., Scott, D. L. and Rea, H. E.** Various herbicides were applied to sandy soil in Northwest Texas for bindweed control in March, 1957. Duplicate randomized square plots were used, and rates of application are specified in pounds per square rod. Results obtained 18 months after treatment are given here. Eradication from PBA applied at ⅛, ¼, and ½; a DBM (sodium borates + 7.5% 2,4-D acid) at 7; erbon at 1 and fenuron at ¼, ⅜, and ½. Some survival of bindweed but a minimum of 90 percent control from sodium chlorate applied at 3, 5, and 7 and monuron at ¼ and ⅜. Less than 90 percent control from anhydrous sodium tetraborate (Concentrated Borascu) applied at 12, 16, and 18; propylene glycol butyl ether ester of silvex at ¼ and ½; alkanolamine salt (ethanol and isopropyl series) of 2,4-D at ½ and DBM at 3 and 5. Eight months after treatment rye grew normally on all PBA, sodium tetraborate, DBM, silvex and 2,4-D treated plots. Growth was poor on sodium chlorate plots and completely inhibited on monuron and fenuron plots. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agricultural Experiment Station and USDA, cooperating.) Approved as TAES T.A. 3053.

## HOARY CRESS

**Treatment of hoary cress in small patches. Best, K. F. and B. J. LeGrand.** Treatment of hoary cress with Concentrated Borascu at rates of up to 6 lb/100 sq ft have had little effect in the Agricultural Representative District No. 9 of southwest Saskatchewan. The best result for the control of hoary cress in this area is to burn the top growth down with treatments of 2,4-D ester at rates of at least 1 lb/A at the bud stage. (Canada Department of Agriculture, Experimental Farm and Saskatchewan Department of Agriculture, Agricultural Representative Service, Swift Current, Sask.).

**The effect of borate compounds on Russian knapweed and hoary cress, 1958. Selleck, G. W.** Concentrated Borascu (61.5% $B_2O_3$) at rates of 1, 2, and 4 lb and a BDM (43.2% $B_2O_3$ and 7% 2,4-D) at ½, 1 and 2 lb/100 sq ft were applied to globe-podded hoary cress and Russian knapweed on alluvial clay soil at Log Valley and Leader, Sask. The herbicides were applied July, 1956 with a 4-ft Gandy spreader to plots 16 x 100 ft. No control of either species was obtained at Leader in 1958 even with the heaviest rates. The heaviest rates of Concentrated Borascu and BDM controlled Russian knapweed 80% and 70% respectively at Log Valley. The hoary cress was not visibly affected. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

## CANADA THISTLE AND PERENNIAL SOWTHISTLE

**Control of Canada thistles with butyric- and acetic-acid phenoxy herbicides. Buchholtz, K. P.** Plots 12 by 15 feet in size were established in cropland in a relatively heavy stand of Canada thistle. Preliminary counts were made in May 1956 and plots grouped into four replicates with similar stands of thistles. Plots were sprayed on June 12, 1956, with 1 lb/A each of MCPA and 2,4-D as amine preparations Amine preparations of 4(2,4-DB) and 4(MCPB) were applied at 0.5, 1.0 and 2.0 lb/A each. Ester preparations of 4((2,4-DB) and 3(MCPB) were applied at 1.0 lb/A. In addition a mixture of amine preparations of 2,4-D and 4(2,4-DB) at 0.125 and 1.0 lb/A was also applied. All treatments were applied using water equal to 20 gal/A when the thistles were in the early bud stage. The area was plowed and worked smooth on July 30, 1956. Counts of thistle shoots were obtained in quadrats in each plot on Sept. 28, 1956, and again on June 7, 1957.

| Material | Appl. lb/A | Thistle shoots/sq ft[1] 9/28/56 | 6/7/57 |
|---|---|---|---|
| MCPA | 1.0 | 0.50a | 1.15a |
| 4(MCPB) amine | 2.0 | 0.56a | 1.47a |
| 2,4-D | 1.0 | 0.83ab | 1.48a |
| 4(MCPB) ester | 1.0 | 0.80ab | 1.73a |
| 4(2,4-DB) amine | 2.0 | 0.90ab | 1.87a |
| 4(2,4-DB) ester | 1.0 | 0.94ab | 2.23ab |
| 4(MCPB) amine | 1.0 | 0.75ab | 2.34ab |
| 2,4-D + 4(2,4-DB) | 0.125 + 1.0 | 1.15ab | 2.61ab |
| 4(2,4-DB) amine | 1.0 | 1.28ab | 3.29ab |
| 4(MCPB) amine | 0.5 | 1.54b | 4.29bc |
| 4(2,4-DB) amine | 0.5 | 2.65 | 6.05c |
| Check | — | 4.09 | 8.53 |

[1] Values adjacent to the same letter are not significantly different.

Close comparisons were not possible because of the variability of the data. MCPA and 2,4-D appeared to be about equal in effectiveness. MCPA and 2,4-D may have been somewhat more effective than 4(MCPB) and 4(2,4-DB) when applied at 1 lb/A. When considered on

an overall basis, 4(MCPB) was more effective than 4(2,4-DB) in reducing the thistle stands. There was some evidence that the ester preparations of 4(MCPB) and 4(2,4-DB) were more effective than the amine preparations. The mixture of 2,4-D and 4(2,4-DB) was intermediate in effectiveness between 4(2,4-DB) applied at 1 and 2 lb/A. Shoot counts obtained in 1957 were higher than those secured in 1956 indicating recovery of the thistles. The densities of the stands were in the same order in the 2 years, with only one exception. (Dept. of Agronomy, Univ. of Wisconsin, Madison.)

**Top growth control of Canada thistle in barley with herbicides. Friesen, H. A.** The butyl esters of 2,4-D and MCPA; butoxy-ethanol ester of 2,4-D; 1,1'-ethylene-2,2'-bipyridnium dibromide (FB-2); isopropylamine salt of 2,4-D (Diax spray powder); and 2-(MCPP) were each applied at rates of 8 and 16 oz/A. The sodium salt of 4-(MCPB) was applied at 16 oz/A and the butyl ester of 4-(2,4-DB) was applied at 8 and 16 oz/A. Water at 6 gal/A was used as the carrier. The Canada thistle was about 4 inches tall and the barley in the 5-leaf stage at the time of spraying. The trial was conducted at different locations. All treatments resulted in excellent suppression of the top growth, except FB-2 at both rates and 2-(MCPP) at the 8 oz/A rate. The treatments reduced the dry matter production of the thistles by 80-90 percent. The higher rate of each herbicide resulted in the greater reduction. The untreated plots produced 2,000 pounds of thistle per acre. FB-2 at 8 oz/A reduced the dry weight of Canada thistle by only 50 per cent while 2-(MCPP) at the 8 oz/A rate reduced it by nearly 70 per cent. Those treatments which reduced the thistle (dry weight) by 80 per cent or more increased the yield of barley by 5 to 10 bu/A. (Contributed by the Experimental Farm, Lacombe, Alberta.)

**Control of Canada thistle and perennial sowthistle in cropland. Keys, C. H. and Forsberg, D. E.** On June 24, the following chemicals were applied to a mixed infestation of Canada thistle and perennial sowthistle in a crop of Ajax oats that was about eight inches tall: butyl ester of 2,4-D; butoxy ethanol ester of 2,4-D; isoctyl ester of 2,4-D; butyl ester of MCPA; isopropanolamine salt of 2,4-D (Diax); each at rates of 4, 8, and 16 oz/A; 4-(2,4-DB) at 8, 16, and 32 oz/A; and 3-(3,4-dichlorophenyl)-1,1-diethylurea at 2, 4, and 8 lb/A. The plot arrangement was a randomized block with four replicates and one untreated or check treatment.

Weed scores were taken prior to spraying and again at harvest time (August 14). Visual estimates of top growth control were made for each plot and the crop was sampled for yield of grain.

Weed scores or counts on Canada thistle were inconclusive as none of the treatments completely killed the top growth, therefore there was no reduction in actual counts. The percentage top growth control by the chemicals is summarized in the following table.

| Chemical | Percent topgrowth control at (oz/A) | | | | | |
|---|---|---|---|---|---|---|
| | 4 | 8 | 16 | 32 | 64 | 128 |
| Butyl ester 2,4-D | 10 | 30 | 70 | | | |
| Butoxy ethanol ester 2,4-D | 10 | 30 | 40 | | | |
| Isooctyl ester 2,4-D | 0 | 10 | 40 | | | |
| Butyl ester MCPA | 0 | 20 | 55 | | | |
| Isopropylamine salt 2,4-D | 5 | 10 | 50 | | | |
| 4(2,4-DB) | | 15 | 40 | 60 | | |
| 3-(3,4-dichlorophenyl)-1,1 diethylurea | | | | 5 | 5 | 10 |

Analysis of the yield data showed that the butyl ester of 2,4-D at 16 oz/A reduced the yield significantly. All other yields were higher than the check plot. Very limited numbers of perennial sowthistle made the evaluation of control of this weed unfeasible. It was evident, however, that they were more susceptible to the treatments than Canada thistle. (Contribution from Experimental Farm, Scott, Sask.)

**Two formulations of amitrol and a triazine derivative for Canada thistle control. Lee, O. C. and Morre, D. J.** Triplicated plots of Canada thistle in an established bluegrass sod were treated June 5, 1958. Thistle plants were in the early bud stage. Prior to treatment, thistle stems were counted on an 8 x 16 ft area located in the center of each 10 x 20 ft plot. Materials used (applied in 20 gpa water) were amitrol in liquid and powder formulations and 2-chloro-4-methylamino-6-isoproyl-amino-*s*-triazine (Geigy 30026) as a wettable powder. Recovery counts were obtained Oct. 4, 1958.

| Material | Lb/A | Recovery, percent of original stand |
|---|---|---|
| Amitrol, liquid | 1 | 29 |
| | 2 | 21 |
| | 4 | 32 |
| powder | 4 | 17 |
| Geigy 30026 | 2 | 94 |
| | 4 | 55 |
| No treatment | | 108 |

(Department of Botany and Plant Pathology, Agricultural Experiment Station, Purdue University).

**Chemical control of Canada thistle in a brome-alfalfa mixture. McCurdy, E. V.** Plots of Canada thistle were treated in 1957 with 4, 8, and 16 lb/A of amitrol. Little was accomplished at the 4 lb/A rate, plants were thinned at the 8 lb/A and control was quite effective at 16 lb/A. Additional plots were treated in July 1958 at 8, 12, and 16 lb/A. At 8 lb/A thistles were retarded but were not killed. At this rate bromegrass was not severely injured but the alfalfa was removed from the mixture. All dandelions were killed. At 12 lb/A control of Canada thistle and dandelions was excellent and sowthistle was severely retarded. At 16 lb/A all regrowth of any of the above weeds was prevented. The dimethylamine salt of trichlorobenzoic acid (Tryben 200) was applied at 8 and 12 pounds per acre. At 8 lb/A the weed was quite severely injured but some regrowth was noted. Alfalfa was thinned. The Canada thistle has not made any further growth since treatment at 12 lb/A but cannot be considered dead. At this rate alfalfa was completely killed. Sowthistle remained in the rosette stage and dandelions were twisted and brown. An ester of 2,4-D (Dow's formula, mixed esters) at 1 lb/A was applied to Canada thistle and it has not made much regrowth. Alfalfa was not completely removed from the mixture at this rate of 2,4-D. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

**Use of liquid amitrol on Canada thistle. Monnie, James B.** A one acre plot heavily infested with Canada thistle was laid out in upland vegetation. In one dense area there were 54 plants in a square yard. On June 19, (an early flower stage) the plot was sprayed with liquid amitrol, at 4 lb/A in 80 gal/A of water, applied with a Broad-jet sprayer.

On September 19, no live plants could be found in the entire acre. Fifty plants were dug and all showed the roots to be rotted, some to the extent that only a few fibres were keeping the upper and lower root systems intact. This area will be checked again next spring to determine if any re-growth occurs. (U. S. Fish and Wildlife Service, Sand Lake Refuge, Columbia, S. Dak.)

**Several chemicals applied as soil sterilants on Canada thistle in Western Nebraska. Nash, R. L. and Wicks, G. A.** Chemicals were applied on Canada thistle at Whitney, Nebraska, November 26, 1957. Since this was a demonstration plot there was only one replication. Plot size was one square rod. The chemicals used were: a BDM (DB Granular) at 6 and 8 lb/sq rd; sodium chlorate at 6 and 8 lb/sq rd; anhydrous sodium borate (Conc. Borascu) at 15 and 18 lb/sq rd; erbon at 80 and 160 lb/A; simazin at 20 lb/A; silvex at 40, 60, and 80 lb/A; potassium salt of MCP (Kalzate A) at 32 and 48 lb/A; amine PBA at 32 and 48 lb/A; PBA (80% TBA) at 32 and 48 lb/A; PBA at 32 and 48 lb/A; and 2,3,6-TBA at 16, 32, and 48 lb/A.

Chemicals giving excellent control were: DB Granular at 8 lb/sq rd; sodium chlorate at 6 lb/sq rd; Kalzate



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A at 48 lb/A; amine PBA at 48 lb/A; PBA (80% 2,3,6-TBA) at 32 and 48 lb/A; PBA at 32 and 48 lb/A; 2,3,6-TBA at 16, 32, and 48 lb/A. Those giving satisfactory control were: simazin at 20 lb/A; silvex at 80 lb/A; and sodium chlorate at 8 lb/sq rd. Those giving unsatisfactory control were: DB Granular at 7 lb/sq rd; Conc. Borascu at 15 and 18 lb/sq rd; erbon at 80 and 160 lb/A; silvex at 40 and 60 lb/A; Kalzate A at 32 lb/A; and amine PBA at 32 lb/A. (Contributed by University of Nebraska Experiment Station, North Platte, Nebraska, and Nebraska Department of Agriculture and Inspection, Division of Noxious Weeds, Lincoln, Nebraska)

## BUR RAGWEED

**Soil applications of herbicides to control bur ragweed. Nash, R. L., and Wicks, G. A.** This report is a summary of work at two locations, one at Elwood and the other at Wallace, Nebraska. The Wallace location was reported on in 1957. The chemicals were applied October 27, 1956, at Wallace and November 27, 1956 at Elwood on square rod plots of bur ragweed.

At Wallace, Nebraska, in September of 1957, those chemicals giving excellent control were: sodium chlorate at 5 and 7 lb/sq. rd; anhydrous borax (Conc. Borascu) at 15 lb/sq rd; a BDM (DB Granular) at 5 and 7 lb/sq rd; a CBMM (Chlorea) at 5 and 7 lb/sq rd; erbon at 120 and 160 lb/A; 2,3,6-TBA at 40 and 60 lb/A; 2,4-D amine at 60 lb/A; MCP potassium salt at 40 lb/A; MCP lithium salt at 40 lb/A; PBA (80% TBA) at 20 and 40 lb/A; and PBA at 40 lb/A. The chemicals giving satisfactory control were: 2,4,5-T ester at 40 lb/A, 2,4-D isooctyl ester at 60 lb/A, 2,4-D amine at 40 lb/A; 2,4-D potassium salt at 40 lb/A; 2,4-D lithium salt at 40 lb/A; PBA at 20 lb/A; and 2,4,5-T amide at 40 lb/A. The rest of the chemicals were unsatisfactory.

One year later at Wallace those chemicals giving excellent control were: sodium chlorate at 5 and 7 lb/sq rd; Chlorea at 5 and 7 lb/sq rd; erbon at 160 lb/A; 2,3,6-TBA at 40 and 60 lb/A; diuron (Karmex DW) at 80 and 160 lb/A; MCP potassium salt at 40 lb/A; MCP lithium salt at 40 lb/A; and PBA (80% TBA) at 40 lb/A. The chemicals that gave satisfactory control were: DB Granular at 7 lb/sq rd; and Conc. Borascu at 15 lb/sq rd. The other chemicals and rates were unsatisfactory.

The chemicals applied on bur ragweed in 1956 at Elwood, Nebraska, were: MCP potassium salt at 20, 40, and 60 lb/A; 2,3,6-TBA at 20, 40, and 60 lb/A applied with oil and water alone; silvex at 20, 40, and 60 lb/A; isooctyl ester of 2,4-D at 40, 60, and 80 lb/A applied with oil and water alone; and 2,4-D diethanolamine at 40, 60, and 80 lb/A.

After two years, the applications of 2,3,6-TBA at all rates with both oil and water gave excellent controls. The other treatments were unsatisfactory. (Contributed by University of Nebraska Experiment Station, North Platte, Nebraska, and Nebraska Department of Agriculture and Inspection, Division of Noxious Weeds, Lincoln, Nebraska).

## TOADFLAX

**Treatment of toadflax in small patches. Best, K. F. and B. J. LeGrand.** Small patch treatment of toadflax with anhydrous borax (Concentrated Borascu) at rate of 3½-4 lb per 100 sq ft has resulted in the eradication of this weed. This work was conducted in the Agricultural Representative District No. 9 covering 11 municipalities. These results were obtained on all soil types encountered in the area where the weed was growing. Toadflax was eliminated from a lilac hedge using 2 lb/100 sq ft with no apparent damage to the lilacs after three years. Similar treatment of toadflax around maples and caragana bushes has proven to be harsher on the maples than on the caragana although neither were destroyed. (Canada Department of Agriculture, Experimental Farm, and Saskatchewan Department of Agriculture, Agricultural Representative Service, Swift Current, Sask.).

**Control of toadflax by 2,4-D in combination with a competitive grass. Carder, A. C.** An area heavily infested with toadflax was partially fallowed in 1952, fitted for seeding in the spring of 1953, when half of the area was sown to creeping red fescue and the other half to brome. Good stands of grass were obtained along with a considerable growth of toadflax consisting mostly of resprouts from the roots of older plants. No nurse-crop was used with the grasses. In the summers of 1953 through to 1958 when the toadflax was in late bud, the butyl ester of 2,4-D was applied by boom plot sprayer to quadruplicate plots at nil, 1, 2, 3, and 4 lb/A in aqueous solution at 10 gal/A. Appraisal of toadflax suppression was made in the fall of each year treatment was carried out. The data in the table show that meadow grasses offered over the course of time heavy competition to toadflax even without the application of 2,4-D. Brome seemed particularly aggressive. The additional suppressive effect of the 2,4-D treatments on the toadflax was at first marked but decreased in subsequent years.

| Grass inclusion | Lb/A | Percent survival* of toadflax | | | | | |
|---|---|---|---|---|---|---|---|
| | 2,4-D | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
| Creeping red fescue | nil | 80.0 | 50.0 | 22.0 | 13.8 | 13.2 | 6.1 |
| | 1 | 72.0 | 34.0 | 9.8 | 6.0 | 4.2 | 1.8 |
| | 2 | 64.0 | 25.5 | 9.2 | 3.8 | 2.2 | 0.4 |
| | 3 | 32.0 | 14.0 | 7.8 | 3.2 | 2.2 | 0.5 |
| | 4 | 24.0 | 10.0 | 7.0 | 2.8 | 1.5 | 0.1 |
| Bromegrass | nil | 80.0 | 40.0 | 10.2 | 2.5 | 3.5 | 1.4 |
| | 1 | 48.0 | 29.6 | 5.8 | 2.5 | 1.5 | 0.5 |
| | 2 | 40.0 | 24.4 | 5.8 | 2.5 | 2.2 | 0.5 |
| | 3 | 24.0 | 12.8 | 2.8 | 1.0 | 0.0 | 0.0 |
| | 4 | 24.0 | 8.8 | 2.0 | 0.8 | 1.2 | 0.0 |

* Arbitrary estimates by same appraiser.

Where 3 and 4 lb/A of 2,4-D were used each year for 6 years combined with bromegrass, the toadflax entirely disappeared. At the 1 and 2 lb/A rates with brome and at the 2 and more lb/A rates with fescue almost complete elimination of toadflax was effected. It was noticed that wherever one or more pounds of 2,4-D had been applied no viable toadflax seed was produced in any year. (Contribution of Experimental Farm, Beaverlodge, Alberta.)

**Effect of herbicides on control of toadflax. Keys, C. H.** For the past eight years monuron applied at 40 + 40 (one year apart), 80 and 100 lb/A has resulted in complete sterility. Growth on plots receiving Atlacide or CBM (Polybor chlorate) at rates up to 1200 lb/A returned to normal about four years after application. However, toadflax has been moving into these plots from the surrounding area. Observations of plots treated, in 1956, with anhydrous borax (Concentrated Borascu) (boron trioxide 65%), a BDM (DB granular), and a BMM (Ureabor), in established stands of crested wheat grass at ½, 1, 2, 3, 4, and 6 lb/100 sq ft indicated that there has been little change over the past year. Plots treated with Ureabor at 3 lb or more remained completely sterile. The 1 and 2 lb rates provided reasonably good control but damage to the grass was severe at the heavier rate. DB granular killed the grass at the 4 and 6 lb rates but the 2 and 3 lb rates look quite promising in that good top growth control and very little damage to the grass has resulted. Concentrated Borascu has provided good top growth control of toadflax at the 2 lb rate and higher, with spotty grass damage at the 4 and 6 lb rates. The ½ and 1 lb rates of BDM and Conc. Borascu have not been adequate for the purpose intended. Heavy rates of 2,4-D ester, 25 to 80 lb/A, have given fair control of top growth but the degree of control has not been proportional to the rate used. Fall applications of BDM and Ureabor at 2 and 3 lb/100 sq. ft. caused a higher degree of grass damage than spring applications but very little if any improvement in toadflax control. (Con-

tribution from the Experimental Farm, Scott, Saskatchewan.)

**Combination of chemical and cultural treatments for toadflax. Keys, C. H.** In early May, 1957, a BMM (Ureabor), a BDM (DB granular) and anhydrous borax (Concentrated Borascu) were applied to lightly infested land to be fallowed at rates of ½, 1 and 2 lb/100 sq ft. Two subsequent tillage operations were all that was required to eliminate all top growth during the fallow year. In the spring of 1958 the area was prepared and sown to wheat. The crop emerged evenly but soon after emergence the plots treated with Ureabor killed out completely and remained bare all season. Concentrated Borascu and DB granular at 2 lb/100 sq ft killed the crop but Russian thistle grew in abundance. At 1 lb/100 sq ft there was about twenty percent survival of crop and thistle grew readily. DB granular at ½ lb/100 sq ft resulted in a normal crop and weeds were absent.

Concentrated Borascu and DB granular were applied June 3, 1958 to an area being fallowed at the following rates: DB granular at ¼, ½, 1, 2, and 3 lb/100 sq ft and Concentrated Borascu at ½, 1, 2, and 3 lb/100 sq ft. All the plots were tilled with a oneway on Aug. 5 and on re-checking the area on Sept. 18 it was noted that there was some regrowth on all plots. Amitrol was applied at 8 lb/A on July 25 to an area of fallow infested with toadflax. Ten days later one-fifth of the treated area was turned over with a one-way. At weekly intervals thereafter (for 3 weeks) a portion of the area was worked down and one plot was left undisturbed for a check. On Sept. 18 regrowth on the plot receiving the first post-spraying tillage appeared quite normal. Regrowth on the plot tilled one week later showed a number of shoots that were discolored and beginning to deteriorate. A higher percentage of affected regrowth shoots were found in the plot that was tilled 24 days after treatment. There was no regrowth on the plot that was worked 31 days after treatment. The final assessment of these treatments will not be known for another year. (Contribution from the Experimental Farm, Scott, Saskatchewan.)

**Cultural treatments of fallow and stubble for toadflax control. Keys, C. H.** Five years' data are now available from the fallow treatments and post-harvest tillage treatments for the control of toadflax. Fallow treatments included (1) black or intensively tilled fallow (2) fallow that allowed about a week of regrowth between operations (3) black fallow using a oneway for initial spring tillage; and (4) black fallow using a plough for initial spring tillage. Post-harvest tillage of stubble included (1) ploughing (2) blade weeding (3) cultivating (4) onewaying and (5) no tillage or check. Weed counts in May 1954 showed that within patches the number of shoots ranged from 10-66 with a mean of 33/sq ft. The patches averaged from 10-15 per plot with many scattered shoots. This year post-harvest counts on summer-fallow treatments revealed only 1 shoot in 24 sq ft counts. There was little or no difference between treatments. The degree of control that can be attributed to post-harvest tillage operations has been quite substantial particularly when the operations are followed by a second crop. There has been very little difference between treatments but the treatments have shown a reduction of 75-95% when compared to the untreated check plot. When the treatments precede fallowing their effects are over-shadowed by the control that fallowing provides. (Contribution from the Experimental Farm, Scott, Saskatchewan.)

**Rotational practices for toadflax. Keys, C. H.** For the past five years rotation practices have been compared to determine their potentialities in controlling toadflax. The results of this year's work follows very closely the results of the previous four years. An alternate fallow and wheat sequence over this period has practically eliminated toadflax. Actual counts have shown that the infestation at present is considerably less than 1% of the infestation at the beginning of the cropping sequence. Two years of fallow and one crop have not shown any improvement over the alternate fallow and crop method. A rotation of fallow, wheat and barley has shown the infestation in the fallow crop to be very low, about 1%, and from 5-10% increase in the stubble crop. To hold the increase in infestation in a stubble crop to a minimum, thorough post-harvest and preseeding tillage is essential. (Contribution from the Experimental Farm, Scott, Saskatchewan.)

**The effect of borate compounds on toadflax in rye, 1958. Selleck, G. W.** Concentrated Borascu (61.5% $B_2O_3$) at 1 lb and a BDM (43.2% $B_2O_3$, 7% 2,4-D) at 0.5 lb/100 sq ft were applied to toadflax in a crop of spring rye in duplicated, 20 x 20 ft plots on sandy-loam soil June 19, 1957. Concentrated Borascu and borate-2,4-D maintained 95% and 80% control respectively of the toadflax. The stand of volunteer rye in 1958 was decreased only in the plots treated with Concentrated Borascu. Concentrated Borascu at 1, 2 and 4 lb and a BDM at 0.5, 1 and 2 lb/100 sq ft were applied to toadflax on 16 x 100 ft plots at Parkbeg on sandy-loam soil May 26, 1955. A portion of the plots was broken up in 1957 and seeded to fall rye. The stand of rye was reduced by the 2 lb and 4 lb/100 sq ft rates of Concentrated Borascu. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

## OTHER PERENNIAL WEEDS

**Chemical control of climbing milkweed. Anderson, L. E.** Foliar applications of various herbicides were made July 8 and 9, 1957, to rapidly growing climbing milkweed plants that were from 8 to 10 inches tall. The following chemicals were applied to square rod plots in three replications: 2,3,6-TBA at 20 and 40 lb/A; polychlorobenzoic amine at 10, 20, 40 and 60 lb/A; lithium 2,3,6-TBA at 8 and 16 lb/A; potassium 2,3,6-TBA at 8 and 16 lb/A; amitrol at 8 and 16 lb/A; MH at 8 and 16 lb/A; simazin at 12 lb/A; erbon at 80 and 160 lb/A; and 4-(2,4-DB) at 4 and 8 lb/A. The amitrol and MH treatments were followed by plowing two weeks after the applications were made.

In September, 1958, 2,3,6-TBA at 20 and 40 lb/A; polychlorobenzoic amine at 40 and 60 lb/A; erbon at 80 and 160 lb/A; and amitrol at 8 lb/A followed by plowing, gave excellent control. Addition of wetting agents did not appear to increase effectiveness of the herbicides. Other herbicides included in the study did not give satisfactory control at the rates used. (Contribution of the Kansas Agricultural Experiment Station.)

**Control of poverty weed by competition. Best, K. F.** Irrigated fields of heavy clay soil at Rush Lake were sown to various grass and legume mixtures during the summer of 1957. The small scattered patches of poverty weed have been suppressed to a marked degree wherever a mixture of crested wheatgrass and alfalfa have become established. The vigor of the weed has been definitely affected by the competition from the established mixture. (Canada Department of Agriculture, Experimental Farm, Swift Current, Saskatchewan.)

**Effect of certain herbicides on yellow nutgrass. Blanchard, K. L., Kommedahl, T., and Anderson, R. B.** Yellow nutgrass growing in peat was treated with EPTC in pre-emergence applications of 5 and 10 lb/A, dalapon at 5, 10, and 15 lb/A, amitrol at 2, 4, and 6 lb/A, and the dimethylamine salt of 2,4-D at 30 lb/A, in triplicate plots. EPTC was incorporated into the soil to a 2-inch depth in two plots and not incorporated into soil in a third plot. In soil incorporated with EPTC germination of 90 per cent of the tubers were inhibited



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(but the tubers were not killed) for both rates, while in soil on which EPTC was not incorporated virtually all, if not all, of the tubers germinated. Amitrol and dalapon at any of the rates tested killed top growth but new shoots arose from the crown or tubers of plants about two weeks after application. The high rate of 2,4-D caused leaf abscission and hypertrophy of the stem and subsequently new shoots were produced from axillary buds of treated plants. (Contribution of the Minnesota Department of Agriculture and the Department of Plant Pathology and Botany, University of Minnesota. Paper No. 4011, Scientific Journal Series, Minnesota Agricultural Experiment Station.)

**Effect of perennial application of 2,4-D and MCPA on field horsetail and yield of barley. Dobb, J. L., Carder, A. C. and Hoyt, P. B.** Different rates of 2,4-D and MCPA were applied in 1956 to barley in the milk stage when field horsetail was fully emerged. These treatments were repeated in 1957 and 1958 to the same plots. Per cent topgrowth kill of the horsetail following treatment and the density of its stand in 1958 resulting from treatments in 1956 and 1957 are presented in the table along with the average yield of barley following the first two applications. Plots were 1 sq rod in size and in triplicate. The chemical was knapsack sprayed in water solution at the rate of 40 gal/A.

| Oz/A active ingredient | 2,4-D | | | | MCPA | | | |
|---|---|---|---|---|---|---|---|---|
| | % topgrowth kill | | % stand | Barley Bu/A | % topgrowth kill | | % stand | Barley Bu/A |
| | 1958 | 3-yr. av. | 1958 | 2-yr. av. | 1958 | 3-yr. av. | 1958 | 2-yr. av. |
| 0 | 0 | 0 | 95.3 | 50.4 | 0 | 0 | 79.0 | 57.5 |
| 4 | 98 | 99.3 | 40.0 | 54.3 | 98.3 | 98.1 | 20.7 | 59.4 |
| 8 | 100 | 100 | 36.7 | 50.4 | 100 | 100 | 18.3 | 62.7 |
| 12 | 100 | 100 | 33.3 | 48.8 | 100 | 100 | 16.7 | 58.2 |
| 16 | 100 | 100 | 53.3 | 48.3 | 100 | 100 | 23.0 | 50.8 |

The data show that: 1) 4 oz/A of either 2,4-D or MCPA gave virtually complete topgrowth kill of horsetail; heavier rates gave complete topgrowth kill, 2) marked reductions in stand of horsetail were effected by two consecutive applications of the chemicals; the greater reductions resulting from the use of MCPA, 3) increasing the rate of chemical over 4 oz/A did not appreciably increase the reduction of stand of horsetail, and 4) the yield of barley was not substantially reduced by any treatment although rates of 8 oz/A or more of the chemicals induced lodging. (Contribution of Experimental Farm, Beaverlodge, Alberta.)

**Field-scale control of field horsetail with MCPA. Dobb, J. L., Carder, A. C. and Hoyt, P. B.** In 1958, MCPA at 6 oz/A was applied with a 50-foot, self-propelled boom sprayer to barley at different growth stages which, as shown in the table, corresponded with different degrees of emergence of horsetail. Per cent topgrowth kill of horsetail was estimated visually. Grain yield of barley was determined by using a "measurmatic" on a 14-foot self-propelled combine. The entire plot was sampled. Plots were 50 x 250 feet in size and in quadruplicate.

| Growth stage of barley | Emergence of horsetail, pct. | Topgrowth kill of horsetail, pct. | Yield of barley bu/A |
|---|---|---|---|
| 4-5 leaf | 70 | 34 | 17.2 |
| Shot-blade | 100* | 99 | 17.4 |
| Soft dough | 100 | 100 | 16.2 |
| Check | 100 | 0 | 21.9 |
| LSD 5% | | | 3.9 |

* Fully emerged but not fully developed.

The data show a significant yield reduction wherever the chemical was applied. Whether this was due to the effect of the herbicide or to some other factor is not known. The unusually light crops of 1958 caused the swathed grain to settle through the stubble and be missed by the combine pickup. On the other hand, horsetail growth prevented this from happening so that such loss did not occur. It is thought that this fatcor is in large part responsible for the yield reductions. It is not known what yield reduction may have been caused by treading when spraying the crop at the soft dough stage. It is believed to be extremely small with a swather-sprayer as used in this test. Results indicate that the best time to spray is when the barley is at the shot-blade stage since treading is not a factor (the treaded crop fully recovered) and virtually complete topgrowth kill of the horsetail was obtained. (Contribution of Experimental Farm, Beaverlodge, Alberta.)

**The effect of three herbicides on absinthe 1958. Forsberg, D. E.** Well established plants of absinthe were top sprayed on June 3rd with amitrol at 2, 4 and 8 lb/A, a BDM (DB granular at 1 and 3 lb/100 sq ft and a BMM (Ureabor) at 2 and 4 lb/100 sq ft. Amitrol killed all top growth after treatment. However, by fall regrowth had occurred in all plots with 8 lb/A rate still showing a chlorosis effect. The 3 lb/100 sq ft rate of BDM resulted in 100% control, while the 1 lb rate was showing signs of regrowth in the fall. Both the 2 and 4 lb rate of Ureabor effected a 100% kill and no regrowth had occurred in the fall. The final results in this test will have to be assessed in 1959. (Contribution by the Experimental Farm, Scott, Saskatchewan.)

**The effect of various herbicides on absinthe and dandelion, 1958. Selleck, G. W.** The dimethyl amine of 2,4-D, MCPA butyl ester, low volatile esters of 2,4,5-T and 2,4-D-2,4,5-T each at rates of 1 and 10 lb/A active ingredients, a BDM (43.2% $B_2O_3$, 7% 2,4-D) at 259 and 567 lb/A and Concentrated Borascu (61.5% $B_2O_3$) at 535 and 1069 lb/A total product were applied May 22, 1956 to absinthe in plots 20 x 12 ft. Second and third applications were applied to all plots with the exception of the borax compounds June 13, 1957 and May 14, 1958. Both rates of Concentrated Borascu and the 10 lb rates of 2,4-D amine, 2,4-D-2,4,5-T and 2,4,5-T maintained 100% control in September, 1958. The remainder of the herbicides controlled absinthe 75% or less. The stand of grass in all of the plots was in excess of that of the check plot with the exception of the heavier rate of Concentrated Borascu, where the stand of grass was 50% of the check. The May, 1958 applications of 2,4-D amine at 10 lb, 2,4,5-T at 10 lb, 2,4-D-2,4,5-T at 10 lb and MCPA ester at 10 lb completely killed the top growth of dandelions. Concentrated Borascu and BDM maintained 90 to 95% control. The dandelions were set back, but survived the 1 lb/A rates of systemic herbicides. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from Amchem Products Inc.)

**Herbicides for absinthe control, 1958. Selleck, G. W.** The dimethyl amine salt of 2,4-D, low volatile esters of 2,4,5-T and TBA at initial rates of 25 lb/A and amitrol and dalapon at initial rates of 40 lb/A in 35 gal of water were applied with a logarithmic sprayer to duplicate, 15 x 135 ft plots May 23, 1957, on loam soil at Hepburn, Sask. The herbicides were applied when the plants were 8 inches tall. Some of the plots received additional applications at similar rates August 8, 1957, and May 23, 1958. The rate (lb/A) required to provide various percentages of kill September, 1958 for five herbicides is presented in the following table.

| Herbicide | Two treatments 1957 | | | One treatment 1957 | | |
|---|---|---|---|---|---|---|
| | 100 | 95 | 75 | 100 | 95 | 75 |
| | Rate, lb/A, to give above per cent kill | | | | | |
| 2,4,5-T ester | 14.0 | 8.9 | 6.2 | .... | .... | 8.2 |
| 2,4-D amine | 4.5 | 4.0 | 3.7 | X | X | X |
| TBA | 4.2 | 3.1 | 3.0 | 12.7 | 10.8 | 8.5 |
| ATA | 3.6 | 2.4 | .... | 12.0 | 7.2 | 4.4 |
| Dalapon | .... | .... | 20.0 | X | X | X |

X Less than 75% control by the heaviest rate.

With one application in May 1957, followed by another in May 1958, 2,4,5-T ester provided 100%, 95%, and 75% control of absinthe at 10.0, 7.0 and 4.5 lb/A, respectively. With three treatments, two in 1957 and one in May 1958,

100%, 95%, and 75% control was obtained with 2,4,5-T at rates of 9.1, 4.5, and 3.3 lb/A respectively. (Contribution from the Department of Plant Ecology, University of Saskatchewan with financial assistance from Amchem Products Inc.)

**The effects of six herbicides on absinthe, 1958. Selleck, G. W.** Mixed butyl esters of 2,4-D, and low volatile ester of 2,4-D (ACP 129), butoxy ethanol ester of 2,4,5-T, butoxy ethanol esters of 2,4-D-2,4,5-T and erbon, at initial rates of 20 lb/A and mixed chlorinated benzoic and cresoxyacetic acids (Fisons 1815) at an initial rate of 10 lb/A were applied with a logarithmic sprayer to duplicated, 15 x 135 ft plots in a brome, crested wheat grass pasture on loam soil near Hepburn, Sask. Some of the plots rceived a second application July 15, 1958. The rates (lb/A) of six herbicides necessary to control top growth 100, 90 and 75% are presented below.

| Herbicide | One application | | | Two applications | | |
|---|---|---|---|---|---|---|
| | 100% | 90% | 75% | 100% | 90% | 75% |
| | Rate, lb/A, to control topgrowth to above percent | | | | | |
| 2,4-D-2,4,5-T esters | 8.0 | 5.0 | 3.2 | 4.2 | 3.0 | 2.2 |
| 2,4,5-T ester | .... | 16.4 | 15.0 | 7.0 | 4.2 | 0.8 |
| 2,4-D ACP 129 | 18.6 | 2.4 | 1.2 | 8.2 | 2.2 | 0.9 |
| 2,4-D standard ester | 18.5 | 1.9 | 1.2 | 8.8 | 1.6 | 0.9 |
| Erbon | X | X | X | 19.0 | .... | .... |
| Fisons 1815 | 9.0 | .... | .... | .... | 3.2 | 2.3 |

X Less than 75% control by the heaviest rate.

It was usually necessary to approximately double the rate of application in order to raise 90 or 95% control to 100% control. The low volatile esters of 2,4-D did not appear to be more effective than the standard formulations. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from Amchem Products Inc.)

**Herbicides for absinthe in grass, 1958. Selleck, G. W.** The dimethyl amine salt of 2,4-D, low volatile esters of 2,4,5-T, mixed butyl esters of 2,4-D, the butyl ester of MCPA and low volatile esters of 2,4-D-2,4,5-T were applied with a logarithmic sprayer to duplicated plots 15 x 135 ft at an initial rate of 17 lb/A to absinthe in a brome, crested wheat grass pasture on loam soil at Hepburn, Sask. The first application was applied June 21, 1957 when the absinthe was in the early budding stage. Some of the plots were retreated August 8, 1957 and May 23, 1958. The rate of application (lb/A) of various herbicides required to provide 100, 95, and 75% kill, September, 1958, with 1, 2, and 3 treatments are listed in the following table.

| Herbicide | 1 treatment 1957 | | | 2 treatments summer & fall 1957 | | | 2 treatments summer, 1957; spring, 1958 | | | 3 treatments summer & fall, '57; spring, '58 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 100 | 95 | 75 | 100 | 95 | 75 | 100 | 95 | 75 | 100 | 95 | 75 |
| | Rate, lb/A, required to effect above percent kill | | | | | | | | | | | |
| 2,4-D ester | .... | 9.0 | 2.2 | 7.3 | 1.9 | 1.4 | 1.9 | .... | 1.4 | 4.5 | 1.7 | 0.9 |
| 2,4-D amine | 13.4 | 10.0 | 8.5 | 14.8 | 2.6 | 2.2 | 7.0 | 2.6 | 1.1 | 2.6 | .... | 1.9 |
| 2,4,5-T ester | .... | .... | 1.2 | 1.9 | 1.4 | .... | 2.0 | 1.1 | 1.0 | 1.4 | .... | 0.4 |
| 2,4-D-2,4,5-T | 12.5 | 1.7 | 0.7 | 6.3 | 0.7 | .... | 0.6 | 0.4 | .... | 0.5 | 0.3 | .... |
| MCP amine | .... | .... | 3.1 | 11.9 | 2.4 | .... | 5.8 | 2.5 | 1.7 | 1.5 | 1.2 | 0.3 |

The 17 lb rates of all herbicides delayed the grass but did not kill it. In this experiment, 2,4-D and 2,4,5-T esters provided the best results, and one application in each of two years was more effective than two applications in one year. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agriculture Research Foundation.)

**Soil sterilants for parking areas, 1958. Selleck, G. W. and Coupland, R. T.** A CBM (Polybor chlorate) at 2, 4, and 8 lb/100 sq ft, a BMM (Ureabor) (45.4% $B_2O_3$, 4% monuron) at 1, 2, and 4 lb/100 sq ft, fenuron at 25, 50 and 100 lb/A and monuron at 50 lb/A were applied to 10 x 10 sq ft plots in parking areas on north and south sides of the Gymnasium, U. of S. campus, April 29, 1957. About 1 inch of gravel was applied to the area one month after application. Fenuron at the 50 lb/A rate was applied along the entire east side of the building. The percentage control of all species at various rates for four herbicides in the fall of 1957 and 1958 are presented in the following table.

| Herbicide | Rate, lb/100 sq ft | Per cent control | | | |
|---|---|---|---|---|---|
| | | South side | | North side | |
| | | 1957 | 1958 | 1957 | 1958 |
| Polybor chlorate | 2 | 90 | 95 | 95 | 95 |
| Polybor chlorate | 4 | 100 | 85 | 99 | 96 |
| Polybor chlorate | 8 | 100 | 99 | 100 | 100 |
| Ureabor | 1 | 100 | 97 | 97 | 100 |
| Ureabor | 2 | 95 | 99 | 100 | 100 |
| Ureabor | 4 | 95 | 100 | 100 | 100 |
| | lb/A | | | | |
| Fenuron | 25 | 60 | 60 | 100 | 100 |
| Fenuron | 50 | 60 | 50 | 100 | 100 |
| Fenuron | 100 | 90 | 100 | 99 | 100 |
| Monuron | 50 | 60 | 70 | 100 | 100 |

Better weed control was obtained on the north side of the building than on the south side, and fenuron at the 50 lb/A rate maintained 100% control along the east side. Where regrowth occurred, grasses were more prevalent in the Polybor chlorate plots and dandelion and sowthistle in the remainder. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agriculture Research Foundation.)

**Blueweed control with translocated herbicides. Wiese, A. F. and Rea, H. E.** Various herbicides, carriers and times of application for controlling blueweed on Pullman silty clay loam were investigated during the past 4 years. Three replications of randomized blocks or split plots 1 square rod in size were used. Results in 1954 with one pound per acre applied in the bud stage showed that 2,4-D was most toxic, silvex and MCPA were intermediate in toxicity and 2,4,5-T and amitrol were ineffective. Esters usually were more toxic than amine formulations.

In 1955 and 1956 average percents of control with propylene glycol butyl ether esters of 2,4-D and silvex at 1, 2 and 4 pounds per acre were 84, 95, 85, 60, 66, and 54, respectively. The LSD at the 5% level was 24 percent for these averages. Also in 1955 and 1956 it was shown that a minimum of 10 gallons water supplemented with either a wetting agent or diesel oil was required for maximum effectiveness of the propylene glycol butyl ether ester of 2,4-D applied at one pound per acre. Carriers investigated were 10 and 40 gallons of water per acre; 5, 10 and 20 gallons of water plus 2 percent wetting agent; 4, 9 and 19 gallons of water plus 1 gallon of diesel oil; and 10 gallons of diesel oil. Other results showed blueweed was most susceptible to 2,4-D and silvex when the plants were budding. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agricultural Experiment Station and USDA, cooperating.) Approved as TAES T.A. 3051.

**Blueweed eradication with soil sterilants. Wiese, A. F. and Rea, H. E.** During 1954, 1955 and 1956 several soil sterilants were applied to blueweed. The plot size was 1 square rod and the treatments were duplicated each year. The sterilants applied and pounds per square rod were a BDM (92.5% sodium borates + 7.5% 2,4-D) at 4 and 6; sodium chlorate at 3, 5, and 7; anhydrous sodium tetraborate (Concentrated Borascu) at 12, 16, and 20; monuron at ¼, ⅜, and ½; fenuron at ¼, ⅜, and ½; PBA at ⅛, ¼, and ½; and erbon at ½, 1, and 2. PBA and erbon were applied only in 1956. Soil sterilants and pounds per square rod which averaged 96 percent or



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more control, were sodium chlorate at 5 and 7, sodium tetraborate at 12, 16, and 20, fenuron at ⅜ and ½, PBA at ⅛, ¼, and ½; and erbon at 2. Sterilants and pounds per square rod which gave from 90 to 95 percent control were BDM at 4 and 6; and fenuron at ¼. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agricultural Experiment Station and USDA, cooperating.) Approved as TAES T.A. 3050.

## ANNUAL, WINTER ANNUAL, AND BIENNIAL WEEDS

**Soil incorporation of selective herbicides. Antognini, J., H. M. Day, R. Curtis, and G. F. Probandt.** The use of selective herbicides applied prior to weed emergence, in the past, has been limited primarily to soil surface sprays. Recent experimental and commercial results have shown EPTC to have increased activity when incorporated into the soil. Excellent results have been obtained with EPTC incorporated with a disc, harrow, or rototiller prior to seeding or immediately following seeding as well as with cultivation equipment in post-emergence applications. This method of application offers many advantages over surface applications in that the effects of soil moisture and tilth, rainfall, and other environmental and equipment factors are greatly minimized. (Contribution from Stauffer Chemical Company, Research & Development Department.)

**Effect of dates of seeding on stinkweed and Russian thistle. Best, K. F.** Chinook wheat was seeded on fallow and on stubble on April 21, May 1, May 9, and May 20, 1958. The plots were harrowed just prior to each seeding to destroy all weed growth. Weed counts June 24th indicated that the earliest seeded wheat on fallow had 89 plants of stinkweed and 23 Russian thistle per unit area while the plots sown on the first of May had only 47 plants of stinkweed and 21 of thistle per unit area. Eleven stinkweed and 5 Russian thistle plants were counted on the May 9th date of seeding and only two stinkweed and no thistle plants were found on the late sown wheat plots. A similar trend was noted on the stubble land where the successive dates of seeding contained 38, 20, 18, and 1 plants of stinkweed per unit area and 22, 23, 9, and 5 Russian thistle plants. These data substantiate the findings of previous years and indicate that delaying the seeding of spring wheat until mid-May, to permit the destruction of a crop of weeds, will greatly aid in the control of stinkweed and Russian thistle. (Canada Department of Agriculture, Experimental Farm, Swift Current, Saskatchewan.)

**Herbicides for control of weed in Argentine rapeseed. Brown, D. A. Pre-emergence.** CDAA, TCA and EPTC at 4 and 8 lb/A and neburon at 3 and 6 lb/A were applied as an overall spray in 20 gal/A of water four days before rapeseed plants emerged. Weeds prevalent included green foxtail, wild oats, redroot pigweed, lambsquarters, wild buckwheat, cut leaved nightshade, and flat spurge.

| Treatment | Rate per acre lb/A | Overall weed control pct | Yield of seed lb/A |
|---|---|---|---|
| Neburon | 3 | 28 | 700 |
| Neburon | 6 | 46 | 709 |
| CDAA | 4 | 48 | 990 |
| CDAA | 8 | 67 | 1,009 |
| EPTC | 4 | 72 | 1,083 |
| EPTC | 8 | 85 | 1,096 |
| TCA | 4 | 44 | 1,056 |
| TCA | 8 | 63 | 703 |
| Hand weeded check | | 100 | 1,190 |
| Weedy check | | 0 | 901 |

**Post-emergence.** Spraying was done when rapeseed plants were approaching early bud. Weeds prevalent were the same as above.

| Treatment | Rate per acre lb/A | Overall weed control pct | Yield of seed lb/A |
|---|---|---|---|
| CDAA | 3 | 52 | 1,256 |
| CDAA | 6 | 66 | 1,299 |
| TCA | 3 | 60 | 1,290 |
| TCA | 6 | 72 | 1,170 |
| 2,3,6-TBA | 4 | 70 | 674 |
| 2,3,6-TBA | 8 | 84 | 346 |
| MCPB amine | ½ | 65 | 0 |
| MCPB amine | 1 | 73 | 0 |
| Hand weeded check | | 100 | 1,438 |
| Weedy check | | 0 | 1,229 |

A herbicide that will kill both grassy and broad leaved weeds is needed for the rapeseed crop. TBA was the nearest approach to this specification, but it seriously injured the crop. (Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba).

**Herbicides applied to the soil to control wild oats. Brown, D. A.** IPC at rates of 0, 5, 10 and 15 lb/A was applied annually for five years to wheat stubble for barley the succeeding year, and to barley stubble prior to summerfallow, in a three-year rotation of fallow, wheat, barley. Time of applications approximated the 28th day of October. Chemicals was disked thoroughly into the surface four inches. Weather conditions have notably influenced the effect of the chemical. Early freeze-up followed by early deep snow-fall favoured the action of the chemical while the open, snowless winter of 1957-58 gave rise to mediocre control of wild oats in the 1958 crop. In years when wild oats are well controlled, barley has failed to make a useful crop from early seedings. By the time the residual influence of the chemical has dissipated control of wild oats could better be accomplished by pre-seeding tillage for a late crop of barley. At the end of a five-year period of testing the reduction in wild oats is much too small to consider this method of control either practical or useful.

EPTC at 4 and 8 lbA and 1,2,4,5-tetrachlorobenzene (Dow 1112) at 10 and 20 lb/A were applied in the spring of 1958 to soil heavily infested with wild oats. Flax was seeded four days after treatment. The measure of control afforded by the chemicals was expressed in the percent reduction of wild oats culms using the checks as a yardstick. EPTC at 8 lb/A gave 26% control and Dow 1112 at 20 lb/A 22%. At the lower rates none of the treatments gave more than 15 percent control Flax stands varied down to 40 percent on EPTC plots. Results in general were erratic and very disappointing due in large part to the fact that early hot dry weather in 1958 induced growth of wild oats before treatments were applied. (Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba.)

**Maleic hydrazide for the control of wild oats. Brown, D.A.** In 1954 a three-year rotation of fallow, barley, flax was laid down on an area heavily infested with wild oats. That year and each succeeding year crops on one-half the area were given a spray of one pound per acre of maleic hydrazide in 15 gal water at a time when the majority of wild oats seeds were in milk to medium dough stage. Crops on the other half of the rotation area remained untreated. Samples of wild oats seed picked from panicles and also from seed after dropping to the soil surface were used for germination tests. Average germinability of seed over the four-year period; treated seed before falling, 5.4; seed picked from soil surface, 2.3 percent. Seed from untreated plots before falling, 72 percent; after falling, 78 percent. Number of wild oats culms per sq yd in standing crop in 1958; following three previously treated crops 4.3. Seeding each year has been done May 20, before many plants of wild

oats can be destroyed by pre-seeding tillage. Counts of wild oats plants per sq yd on summer-fallow plots previous to the first tillage of the season June 16, 1958 were on the half of the experiment treated with MH, 8.1; on the untreated half, 575. There has been convincing evidence that maleic hydrazide applied to wild oats in the panicle at milk to early dough stage will inhibit germination and that the repeated treatment of corp on a field, after three to five years will bring about control of wild oats. Germination of the accompanying crops of barley and flax has been reduced by 28 and 56 percent respectively. (Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba.)

**Herbicides for control of wild oats in a crop of sunflowers. Brown, D. A.** The following were applied to the soil and disced in as pre-planting treatments one week prior to seeding the sunflowers; EPTC at 5 and 10, and 1,2,4,5-tetrachlorobenzene (Dow 1112) at 10 and 20 lb/A. EPTC at 5 and 10 lb/A was also used as a pre-emergence treatment. Due to extremely hot, dry weather sunflower seeds were greatly delayed in germination. Meanwhile wild oats grew rapidly and the EPTC used as a pre-emergence treatment gave very poor results. As a pre-planting treatment it gave 65 percent control of wild oats throughout the season. Dow 1112 gave irregular results, averaging 58 percent control of the heavy infestation of wild oats. Only at the higher rates were results encouraging. None of the chemicals at the rates used visibly injured the sunflower plants. (Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba).

**4-chloro-2-butynyl *N*-(3-chlorophenyl)carbamate (S-847) for the control of wild oats. Brown, D. A.** Applications of 4, 8, and 16 oz/A were made to wild oats in a wheat crop at the time wild oats plants were passing into the three-leaf stage and wheat was in early shot blade. The chemical inhibited the growth of wild oats plants. At the 16 oz rate the main stem on the majority of plants killed back, forcing the production of new tillers which developed short slender stems, each bearing a few seeds. These spindly plants, to a large extent, succumbed to the competition of a good wheat crop and at the time of harvest few wild oats panicles appeared above wheat heads. Percent control was calculated from the number of wild oats culms in the standing crop and the content of wild oats in the threshed grain. Compared with untreated plots, at 1 lb/A the chemical reduced the incidence of wild oats by 76 percent. Rates lower than one pound gave fair to good results, provided wild oats plants were not further advanced than the two-leaf stage at time of treatment. However, the evidence indicated that application of at least 1 lb/A was required. Crops of wheat and barley were not reduced in yield by this chemical. (Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba.)

**Systemic chemicals on scentless mayweed. Carder, A. C.** On June 10, 2,4-D butyl ester and CP. 1815 (mixture of chlorinated benzoic and cresoxyacetic acids) were applied by boom plot sprayer using a water spray at the rate of 10 gal/A to triplicate plots of an almost solid stand of scentless mayweed, 3-4 in high. This test was conducted to determine the effect of CP. 1815, but the butyl ester of 2,4-D was included because it had proved the most effective systematic herbicide hitherto tried for the suppression of this weed. Procedure and results are shown in the table.

| Chemical | Lb/A active ingredient | Percent topgrowth kill* of mayweed after, weeks | | |
|---|---|---|---|---|
| | | 2 | 6 | 10 |
| 2,4-D | 8 | 55.0 | 28.3 | 10.3 |
| | 12 | 65.0 | 50.0 | 26.0 |
| | 16 | 70.0 | 61.7 | 45.0 |
| CP. 1815 | 8 | 48.3 | 60.0 | 65.0 |
| | 12 | 61.7 | 73.3 | 85.0 |
| | 16 | 71.7 | 76.7 | 89.0 |

* Arbitrary estimate.

Two weeks from treatment there was little difference between the effects of the two chemicals. However, after this time, the effect of the 2,4-D formulation wore off, while that of C.P. 1815 intensified. After 10 weeks most of the mayweed foliage and stem were dead where over 12 lb/A of the latter chemical had been applied. Only the very occasional plant in these plots produced flowering stalks, while the plants in those plots treated with the same rates of 2,4-D flowered profusely, and ripened seed. (Contribution of Experimental Farm, Beaverlodge, Alberta.)

**Chemicals for patch eradication of scentless mayweed. Carder, A.C.** On June 13, the following herbicides were applied to a solid stand of scentless mayweed 4 in high: Atlacide (60% sodium chlorate) at 1, 2, and 3 lb/sq rod; monuron at 8, 10, and 12 lb/A; and amitrol at 6, 8, and 10 lb/A. Plots were one sq rod and in triplicate. The chemicals were knapsack sprayed using an aqueous solution at the rate of 80 gal/A. Periodic examination up to 3 mo after treatment showed that effective kills were obtained by 2 and 3 lb/sq rd of Atlacide and by 10 lb/A amitrol. Where only 1 lb of Atlacide had been applied a growth of seedling plants appeared, while 10% of the original plants recovered from the effect of the chemical. There was a similar amount of recovery with all rates of monuron and the 6 and 8 lb/A rates of amitrol. (Contribution of Experimental Farm, Beaverlodge, Alberta).

**Control of wild oats by pre-planting chemicals. Carder, A. C.** On May 20, EPTC and 1,2,4,5-tetrachlorobenzene (M-1294) were applied to duplicate plots by Gandy spreader to soil prepared for seeding and heavily polluted with a natural infestation of wild oats. The chemicals were immediately incorporated under ideal conditions by double discing, the second working being done crosswise to the first. Soil temperatures were cool. Flax was seeded on the same date over part of the EPTC plots, while barley was seeded over part 3 weeks later. Plots treated with M-1294 were left unseeded. Procedure and results are shown in the table.

| Treatment lb/A | | | No. wild oat panicles per sq yd | Yield grain bu/A |
|---|---|---|---|---|
| EPTC at | Nil | No crop | 65.6 | |
| | 5 | No crop | 0.0 | |
| | 10 | No crop | 0.0 | |
| | Nil | Flax | 10.8 | 13.2 |
| | 5 | Flax | 0.0 | 12.4 |
| | 10 | Flax | 0.0 | 7.4 |
| | Nil | Barley | 16.0 | 31.6 |
| | 5 | Barley | 0.0 | 0.0 |
| | 10 | Barley | 0.0 | 0.0 |
| M-1294 | Nil | No crop | 89.5 | |
| | 10 | No crop | 5.9 | |
| | 20 | No crop | 0.0 | |

The data show that where no crop was seeded a heavy stand of wild oats was eliminated by 5 lb/A or more of EPTC. A similar situation obtained where flax or barley was sown. Flax indicated considerable tolerance to EPTC, but barley none, although sown 3 weeks after incorporation of the chemical. M-1294 was less effective in the control of wild oats than EPTC. Even though 20 lb/A of M-1294 prevented panicle formation, there were scattered undeveloped wild oat plants present, while wherever EPTC had been applied there was none. (Contribution of Experimental Farm, Beaverlodge, Alberta).

**Control of wild oats by cropping and tillage practices. Carder, A. C.** Four 6-year rotations were initiated in 1953 in quadruplicate plots on a field heavily infested with wild oats with the first crop of each rotation being early-spring sown wheat. Thereafter the rotations involved: 1. three delayed-seeded Olli barley crops with a year of fallow after the first two; 2. two crops of winter



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rye with necessary partial fallow in years of seeding; 3. three years of bromegrass sod with a partial fallow in year of breaking; and 4. two rounds of a fallow-wheat sequence. Plots were 20 x 165 ft in size. The test ended, as it began, with a crop of early-sown wheat. Yields of wild oats in these crops are given in the table.

| Rotation | Yield* of wild oats bu/A in spring wheat | | % reduction |
|---|---|---|---|
| | 1953 | 1958 | |
| 1. Delayed-seeded crops | 10.8 | 1.0 | 90.7 |
| 2. Fall-sown crops | 7.9 | 1.7 | 78.5 |
| 3. Sod crop | 7.7 | 3.1 | 59.7 |
| 4. Fallow-wheat rotation | 8.6 | 6.7 | 22.1 |

* Includes seed cleaned from crop plus that picked up from ground.

Results show that over the 5-year period delayed seeding reduced the infestation by 90.7%, the use of fall-sown crops by 78.5%, the use of a sod crop by 59.8% and the use of fallow-wheat sequence by 22.1%. (Contribution of Experimental Farm, Beaverlodge, Alberta).

**1,2,4,5-tetrachlorobenzene for wild oat control. Carder, A. C.** On July 26, 1957, 1,2,4,5-tetrachlorobenzene (M-757) was applied by Gandy spreader at nil, 5, 10, 12.5 and 15 lb/A to land heavily polluted with a natural infestation of wild oats. Immediately following application, the chemical was incorporated into the soil to a depth of 4 in by one-waying twice, the second working crosswise to the first. Packing followed. Soil conditions were ideal for incorporation, moist but not wet. The soil was warm. The test was set up as twin 5x5 latin squares. On September 27, two months after the chemical was applied, a count was made of young wild oat plants that had appeared. Number of square yard were: nil treatment, 4.2; 5 lb/A, 5.7; 10 lb/A, 4.4; 12.5 lb/A, 4.6; and 15 lb/A, 2.2. Tests on wild oat kernels obtained from the different plots in early October showed the following percentages of viable seed: nil, 12.5; 5 lb/A, 16.1; 10 lb/A, 17.1; 12.5 lb/A, 22.4; and 15 lb/A, 6.4. These results suggest that except for the 15-lb rate, the viability of wild oats seed was not reduced by any treatment.

In the spring of 1958, the test area was fitted for seeding and sown to wheat, barley, oats, flax and peas across half of each plot to determine the residual effect of the chemical. The remaining half of each plot was left unseeded to facilitate count of wild oat plants. Vigorous stands of all crops were produced, indicating that any residual effect of the chemical had dissipated before time of planting. All crop stands, particularly flax and peas, were heavily contaminated with wild oat plants. Counts on these plots and those where no crop was sown confirmed the previous autumn's plant count and the seed-viability tests that little or no control of wild oats was effected by any of the chemical applications. (Contribution of Experimental Farm, Beaverlodge, Alberta).

**Comparison of FB-2, LV 2,4-D ester, neburon and DDU sprays on Tartary buckwheat. Corns, Wm. G.** Triplicate randomized plots for each treatment were sprayed on June 30, 18 days after seeding, when the weeds had 3 leaves. The treatments were 1,1'-ethylene-2,2'-bipyridinium dibromide (FB-2) at 0, 4, 8, and 16 oz/A in 50 gal water; butoxyethanol ester of 2,4-D, 6, 8, and 10 oz/A; neburon and 3-(3,4-dichlorophenyl)-1,1-diethylurea (DDU) at 1, 2, and 4 lb/A. Fresh weights of Tartary buckwheat samples from 12 sq ft per plot were determined on Aug. 18. The yields of treated material are given as percent of the control following the rate per acre. FB-2: 4 oz, 106; 8 oz, 86; 16 oz, 70: 2,4-D: 6 oz, 83, 8 oz, 83; 10 oz, 70: neburon: 1 lb, 82, 2 lb, 29, 4 lb, 7: DDU: 1 lb, 122; 2 lb, 97; 4 lb, 56. The superiority of neburon at 4 lb/A is indicated by these tests. (Division of Crop Ecology, Department of Plant Science, University of Alberta).

**Sodium arsenite and FB-2 on Tartary buckwheat and barley. Corns, Wm. G.** Quadruplicate plots of Tartary buckwheat cross-seeded with Gateway barley for each of the following treatments at two stages of growth were planted on May 21. Sodium arsenite, 0, 5, 10, 20 lb/A; 1,1'-ethylene-2,2'-bipyridinium dibromide (FB-2), 0, ½ 1, 2 lb/A; both in 50 gal water. Stages were June 6, buckwheat one true leaf, barley 3-4 leaves; June 17, buckwheat 4-5 leaves, barley approx. 10 leaves. Both chemicals caused pronounced "burning" of the buckwheat at both stages but also had drastic effects on the barley, either killing it or seriously delaying its maturity. The fresh weights of square yard samples of the surviving buckwheat plants at harvest time are given as percentages of the controls, following the rate in lb/A. Sodium arsenite, June 6: 5, 49; 10, 22; 20, 63; June 17, 5, 78; 10, 34; 20, 7: FB-2 June 6: ½, 29; 1, 42; 2, 2: June 17, ½, 72; 1, 54; 2, 24. These herbicides appear to be unsatisfactory for selective control of Tartary buckwheat in barley. (Division of Crop Ecology, Department of Plant Science, University of Alberta).

**Response of Tartary buckwheat at different stages of growth to single or repeated applications butoxyethanol ester of 2,4-D. Corns, Wm. G.** Each treatment was in quadruplicate on seeded plots containing 4 dense rows, 8 ft long, 1 ft apart. Certain plots were sprayed with the butoxyethanol ester of 2,4-D in 50 gal/A water (I) on June 30 at 3 leaf stage and/or (II) on July 8 when plants had 15-20 leaves. The rates and the mean final fresh weights (Aug. 14) expressed as percentage of the controls are tabulated:

| Stage: | I II | I II | I II | I II | I II |
|---|---|---|---|---|---|
| Rates (oz/A): | 0 + 0 | 3 + 0 | 0 + 3 | 6 + 0 | 0 + 6 |
| Fresh wt: | 100 | 93 | 96 | 82 | 56 |
| Rates: | 9 + 0 | 0 + 9 | 12 + 0 | 0 + 12 | 3 + 3 |
| Fresh wt: | 66 | 44 | 68 | 33 | 61 |
| Rates: | 3 + 6 | 6 + 3 | 3 + 9 | 9 + 3 | 6 + 6 |
| Fresh wt: | 17 | 52 | 8 | 33 | 8 |

Contrary to previous findings for Tartary buckwheat in grain, the results here for pure weeds indicated marked superiority of the second stage treatments and for certain rates (3+6, 3+9, 6+6), a superiority of double application over the best comparable single treatment. This may be related to the greater leaf surface and to other characteristics of plants not growing in the understory of a crop. (Division of Crop Ecology, Department of Plant Science, University of Alberta).

**Sensitivity of hemp nettle, ladysthumb and night-flowering catchfly to FB-2. Corns, Wm. G.** Plots 18 sq ft in area were sprayed on July 8 with 2 lb/A 1,1'-ethylene-2,2'-bipyridinium dibromide (FB-2) in 50 gal water. Hemp nettle plants were about 6 in tall; ladysthumb was about 10 in tall and in bud stage; night-flowering catchfly was about 7 in tall. The latter and ladysthumb were "bleached" for a time by the chemical but recovered. About 90% of the hemp nettle plants were killed. (Division of Crop Ecology, Department of Plant Science, University of Alberta).

**Foliage sprays of 4-chloro-2-butynyl *N*-(3-chlorophenyl)carbamate (S-847) for selective control of wild oats in cereals and flax. Corns, Wm. G.** Quadruplicate randomized plots of Thatcher spring wheat, Kharkov winter wheat, Gateway barley and Redwing flax were cross-seeded, in half, with wild oats to permit comparisons of the herbicide on weedy and weed-free crop. Rates of crystalline S-847 were ½, 1, 2, 4 lb/A emulsified in 50 gal water, sprayed June 4, two weeks from seeding, when oats, wheat, and barley had 2-3 leaves and flax 4 leaves. Oats were 3 in tall, flax 1 in, and wheat and barley 5-6 in. Growth of most wild oats was halted by the 2 and 4 lb/A rates, and green color intensified prior to slow death. Barley and flax were temporarily slightly retarded. Wheat was unaffected. Any escaped oats headed by harvest time. Mature crops appeared equal to check except for some lodging of straw in the barley with the 2 and 4 lb/A rates. Mean yields from all plots are tabulated as percentage of respective checks. Because of partial shattering of seeds of wild oats plants,



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percentages based only on their tiller weights and numbers (T) were used.

| Crops | Yields as percent of check yields following treatment at (lb/A) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ½ | | 1 | | 2 | | 4 | |
| | Straw | Grain | S. | G. | S. | G. | S. | G. |
| Spring wheat | 95 | 110 | 105 | 107 | 113 | 122 | 109 | 118 |
| S.W. in wild oats | 116 | 117 | 124 | 129 | 133 | 144 | 142 | 157 |
| Winter wheat | 114 | — | 107 | — | 103 | — | 113 | — |
| W.W. in W.O. | 104 | — | 133 | — | 129 | — | 132 | — |
| Barley | 98 | 97 | 96 | 97 | 88 | 90 | 99 | 101 |
| B. in W.O. | 102 | 103 | 104 | 107 | 111 | 113 | 124 | 130 |
| Flax | 98 | 108 | 85 | 79 | 93 | 103 | 90 | 82 |
| F. in W.O. | 138 | 154 | 252 | 246 | 348 | 328 | 350 | 356 |
| | | T. | | T. | | T. | | T. |
| W.O. in S.W. | 65 | 76 | 45 | 86 | 26 | 55 | 18 | 41 |
| W.O. in W.W | 88 | 120 | 33 | 57 | 45 | 69 | 8 | 18 |
| W.O. in B. | 48 | 71 | 34 | 55 | 31 | 50 | 7 | 14 |
| W.O. in F. | 103 | 121 | 71 | 84 | 12 | 20 | 25 | 33 |

The results indicate clearly beneficial effects of the chemical in all the weedy crops, apparently some adverse effects on clean barley and flax, and no injury to weed-free wheat. (Division of Crop Ecology, Department of Plant Science, University of Alberta).

**Comparison of various chemicals for control of chickweed. Corns, Wm. G.** Dense patches of chickweed beneath apple trees were sprayed in mid-July. Duplicate 16 sq ft plots were used for 1,1'ethylene-2,2'-dipyridinium dibromide (FB-2) at 0, ½, 1, and 2 lb/A; neburon and 3-3,4-dichlorophenyl)-1,1-diethylurea (DDU) at 0, 2, 4, and 8 lb/A; sodium arsenite, 0, 1, 2, 3, 6, and 9 lb/A; each in 50 gal/A water. Results as final percentage of plants killed are tabulated:

| Rates (lb/A) | ½ | 1 | 2 | 3 | 4 | 6 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| FB-2 | 50 | 85 | 97 | — | — | — | — | — |
| Neburon | — | — | 50 | — | 100 | — | 100 | — |
| DDU | — | — | 50 | — | 80 | — | 98 | — |
| Sodium arsenite | — | 25 | 35 | 55 | — | 95 | — | 100 |

Accompanying abstract of results with Kentucky bluegrass indicates that neburon is best for selective control of chickweed in grass. FB-2 appears suitable on chickweed as a non-selective chemical. (Division of Crop Ecology, Department of Plant Science, University of Alberta.)

**Control of peppergrasses in rye. Dowler, Clyde, and Willard, C. J.** Field and Virginia peppergrasses in the rosette stage and rye in the three- to five-leaf stage were treated with 4-(2,4-DB) and 4-(MCPB) at 1, 2, and 4 lb/A in 40 gpa of water on October 15, 1957. On December 30, 1957, 1 lb/A of both compounds appeared ineffective in controlling the peppergrasses, but 2 lb/A of both herbicides gave satisfactory control and 4 lb/A gave very good control. On March 31, 1958, 4-(2,4-DB) at 1 lb/A gave good control of the peppergrasses and all the other treatments gave excellent control. The rye, which was plowed under March 31, was not injured by any treatment. (Contribution of the Ohio Agricultural Experiment Station.)

**Control of summer annual grasses in side oats and switch grasses. Elder, W. C.** This test was conducted in established stands of improved strains of side oats and switch grasses used for seed increase. Chemicals were applied after the crops were 8 inches high and at time of germination of the annual grasses. Weed grasses present were crabgrass, prairie supgrass and *Eragrostis* species. Herbicides and rates used were monuron and diuron at 2 lb/A, neburon at 4 lb/A, EPTC at 8 lb/A and simazin at 3 lb/A. Simazin destroyed all the annual grasses and no injury was observed on the crops. Monuron was less effective on weeds than simazin but superior to diuron. Both monuron and diuron injured switch grass severely but did not affect side oats. Neburon and EPTC did not injure the crops, neither did they control the weed grasses sufficiently to prevent seed contamination. (Contribution of the Agronomy Department, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma.)

**Control of winter annual grasses in smooth brome grass. Elder, W. C.** The test was conducted in a field of Southland brome grass which was planted to produce foundation planting seed. Herbicides were applied in September, 1957. The smooth brome was growing rapidly at the time of treatment. Herbicides and rates used were monuron and diuron at 2 lb/A. Dalapon destroyed most of the annual grasses but it severely injured the smooth brome during the spring months of 1958. Only partial recovery was made by September, 1958. Monuron and diuron destroyed all the annual grasses and increased yields of the crop. TCA and DNBP did not injure the crop nor did they reduce the weed grasses sufficiently to meet certification standards for the crop after combining. (Contribution of the Agronomy Department, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma.)

**Effect of pre-emergence sprays on wild buckwheat. Forsberg, D. E.** In the spring of 1958 a four replicate test was laid out and sprayed with the following herbicides: simazin at 6 and 8 lb/A sprayed one week before seeding and worked in, polychlorinated benzoic acid (Benzac 354), neburon, and 2,4-D ester, at 2 and 4 lb/A top sprayed one week after seeding. Moisture conditions were dry throughout the growing season. An analysis of variance showed no significant yield differences as a result of the treatments applied. Good control of weeds was obtained with all treatments in the test. Based on results over the past 4 years it would appear that 2 lb of 2,4-D ester applied before emergence of grain will give satisfactory control of wild buckwheat or other weeds throughout the growing season. (Contribution from the Experimental Farm, Scott, Saskatchewan.)

**Herbicides on wild buckwheat. Forsberg, D. E.** The following herbicides were sprayed on wild buckwheat in a stand of Chinook wheat at two dates, and in repeated applications; butyl ester of 2,4-D, butoxyethanol ester of 2,4-D (LV4), CP-1815 (mixture of chlorinated benzoic and cresoxyacetic acid), butyl esters of 4-(MCPB) and 4-(2,4-DB), Benzac 354(polychlorinated benzoic acid), Diax(isopropylamine salt of 2,4-D), and FB-2 (1,1'-ethylene-2,2'-bipyridinium dibromide). The first spraying was done while the buckwheat was in the 2-3 leaf stage and grain in the 2-3 leaf stage. The second spray was applied when the buckwheat was in the 4-8 leaf stage and the grain was in the 6 leaf stage. 4-(MCPB) and 4-(2,4-DB) were applied at 16 and 32 oz/A and in two 5 oz/A applications spaced one week apart. All other herbicides were applied at 5 and 8 oz/A and two 5 oz/A applications one week apart. Moisture conditions for the germination of wild buckwheat and grain were excellent. However, the remainder of the growing season was dry and wild buckwheat did not make much growth. The two applications of butyl ester ester of 2,4-D, LV-4, and 4-(2,4-DB) resulted in 87, 84 and 79 percent kill of wild buckwheat, and yield increases of 2.3, 0.9 and 2.3 bu/A, respectively. CP-1815, 4-(MCPB), Benzac 354, Diax and FB-2 did not give satisfactory control of wild buckwheat at the rates and dates used. Benzac 354, Diax and FB-2 in most cases caused yield reduction below the check, delayed maturity, and in the higher rates some epinasty and lax spikes were noted. (Contribution from the Experimental Farm, Scott, Saskatchewan.)

**The effect of early spray application on wild buckwheat. Forsberg, D. E.** Over the last three years wild buckwheat has been sprayed in a field of Chinook wheat when the wheat was emerging or in the first leaf stage. At this time the wild buckwheat is usually in the cotyledon leaf or first true leaf stage. In 1958 the following chemicals were used; butoxy ethanol ester of 2,4-D, and



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butyl esters of 2,4-D, MCPA, 4-(MCPB), and 4-(2,4-DB). Each of these herbicides were applied at 5, 8, 12, and 16 oz/A and also two 5 oz/A applications one week apart. Moisture conditions for germination of grain and wild buckwheat were good. However, the remainder of the growing season was dry and wild buckwheat did not make much growth. In each of the three years that this test has been conducted an analysis of variance on yield data has shown no significant differences. In 1958, as in other years, the two 5 oz/A applications resulted in the highest control of wild buckwheat. To get comparable results with single applications, rates of 12 to 16 oz/A would have to be used. The 4-(MCPB) butyl ester did not give satisfactory control at any rate used, while 4-(2,4-DB) ester gave control equal to 2,4-D ester. However, the higher rates and two applications of 2,4-D had more effect on the yield of wheat, i.e. the 16 oz and two 5 oz applications reduced the yield of wheat by 2 and 4.7 bu/A respectively when compared to the same treatments of 4-(2,4-DB). Butoxy ethanol ester of 2,4-D, when compared to 2,4-D ester, was slightly better in the control of wild buckwheat, but it was more drastic on the yield results of wheat. MCPA ester did not give satisfactory control of wild buckwheat when compared to the 2,4-D ester. However, its reaction on the yields of grain was not as severe as 2,4-D ester. The two applications of 2,4-D ester resulted in 70% kill of wild buckwheat and a 4 bu increase over the check. (Contribution from the Experimental Farm, Scott, Saskatchewan, Canada)

**The effect of neburon on wild buckwheat. Forsberg, D. E.** In the spring of 1958 neburon was sprayed on wild buckwheat in a field of Chinook wheat with a knapsack sprayer. The neburon was applied at 2, 3, 4 and 6 lb/A in 20, 40, 60, 80 and 100 gal/A of water. The grain was sprayed while in the 3rd leaf stage and the buckwheat while in the 4 to 6 leaf stage. Moisture conditions for the growing season were very poor and buckwheat did not make much growth. Also included in this test was 3-(3,4-dichlorophenyl)-1,1-diethylurea at 2, 3, 4 and 6 lb/A applied in 40 gal/A of water. The 3-(3,4-dichlorophenyl)-1,1-diethylurea had no effect on the wild buckwheat at the rates and gallonage of water used. With neubron the effectiveness of each rate of application depended upon the amount of water applied per acre. Percent of kill increased up to where 100 gal of water and 6 lb/A of neburon resulted in 100 percent kill. From these results it would appear that 100 gal/A water is the minimum that should be used for effective control of wild buckwheat with neburon. (Contribution of the Experimental Farm, Scott, Sask., Canada)

**Effect of several pre-emergence herbicides for weed control in corn. Friesen, G.** Canning corn (variety Seneca Hybrid) was planted at Winnipeg, June 6. The area was infested with wild oats, green foxtail, wild mustard and redroot pigweed. Herbicides were applied on June 14, several days prior to corn emergence. Total volume of spray solution was 90 gallons per acre applied with a variable dosage sprayer. Treatments were conducted in duplicate with check plots adjoining each treatment. Herbicides and rates were as follows: simazin, 1-4 lb/A; 2-chloro-4-isopropylamino-6-methylamino-*s*-triazine (G-30026), 1-4 lb/A; 2-chloro-4-isopropylamino-6-ethylamino-*s*-triazine (G-30027) (Atrazine) 1-4 lb/A; EPTC (Eptam), 2-8 lb/A. Simazin gave good control of all weeds throughout the plot with the exception of wild oats, which were controlled only at rates above 2 lb/A. G-30026 gave comparatively poor weed control at all rates. Atrazine was the most effective treatment with no weeds surviving even the lowest dosage used. EPTC gave excellent control of wild oats but only fair control of other weeds. None of the herbicides at the rates used damaged the corn. (Contribution from the Division of Plant Science, University of Manitoba, Winnipeg.)

**Experiments on the selective control of wild oats in cereal crops by post-emergence treatments. Friesen, G.** Three experimental herbicides, 4-chloro-2 butynl *N*-(3-chlorophenyl)carbamate (S-847), *N*-(2,6-dimethylphenyl)-alpha-chloroacetamide (M-625), and another coded product, were evaluated as to effectiveness in selectivity controlling wild oats in wheat and barley. Several formulations of S-847 were included. Experimental trials were conducted at Winnipeg, Lilyfield, Stonewall, Rosser, and Marquette. Treatments were made with a logarithmic sprayer delivering a total of 30 gallons solution per acre. Maximum rates were as follows: S-847, 4 lb/A; M-625, 16 lb/A; the other 8 lb/A. M-625 and the other failed to show selective herbicidal action at even the maximum rates in these trials. The dates of treatment, maximum dosages of S-847, and stages of crop and wild oat growth are presented in the table.

| | | | Stage of growth | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Wild oats | | Wheat | | Barley | |
| Location | Date | Max. rate S-847 lb/A | Ht in | Leaves | Ht in | Leaves | Ht in | Leaves |
| Winnipeg | June 3 | 1 | 3-4 | 2-3 | 5 | 3-4 | 4-5 | 3-4 |
| Lilyfield | May 16 | 4 | 3 | 1-2 | 4-5 | 2 | | |
| | May 29 | 4 | 4-5 | 2-3 | 5-6 | 3 | | |
| | June 14 | 4 | 6-7 | 4-5 | 8-10 | 4-5 | | |
| Stonewall | May 16 | 2 | 3-4 | 2 | | | 5 | 3 |
| Rosser | June 4 | 4 | 3-4 | 2 | | | 5 | 3 |
| Marquette | June 6 | 4 | 3-5 | 3-4 | | | 5-6 | 4 |

**Winnipeg.** Good control of wild oats when rates of S-847 exceeded 8 oz/A. No observable damage to either wheat or barley. **Lilyfield.** Good control of wild oats on May 16 plot when rate exceeded 8 oz/A. Damage to wheat severe at rates exceeding 1½ lb/A. No appreciable control at latter two dates. A second crop of wild oats germinated after early July rains. **Stonewall.** No control of wild oats or damage to barley noted. Severe wind damage about one week after spraying possibly accounts for this failure. **Rosser.** Excellent control of wild oats at rates exceeding 2 lb/A. Damage to barley appreciable when rate exceeded 2 lb/A. One of the more impressive experiments in the series. **Marquette.** No control of wild oats or damage to barley observed. Failure may be accounted for by advanced stages of growth at time of treatment. It would appear that further experiments with S-847 seem warranted. (Contribution from the Division of Plant Science, University of Manitoba, Winnipeg, Canada.)

**Neburon and other herbicides for the selective control of corn spurry in oats. Friesen, H. A.** Neburon at 2, 3 and 4 lb/A was sprayed on corn spurry in oats, when the spurry was 2-3 inches tall and the oats were in the 5-leaf stage. Water at 80 gal/A was used as a diluent. As in the past two years, all rates of neburon resulted in over 95 per cent elimination of the spurry. The removal of the weeds resulted in significant increases in the yield of oats. In a further trial diuron at 2 lb/A; 3-(3,4-dichlorophenyl)-1,1-diethylurea at 1, 2, 3, and 4 lb/A; the butyl esters of MCPA and 2,4-D at 8 and 12 oz/A; and an amine of 2-(MCPP) at 8 and 16 oz/A were sprayed when the corn spurry was 3 inches tall and the oats were in the 5-leaf stage. Diuron resulted in 100 per cent elimination of the spurry. The 3-(3,4-dichlorophenyl)-1,1-diethylurea at rates of 2 lb/A or higher reduced the stand by 75 per cent and the dry weight of the weed by about 90 per cent. Similar control was obtained by the 2-(MCPP) treatments and the MCP ester at 12 oz/A. MCP and 2,4-D esters at 8 oz/A were largely ineffective. The oats showed no marked effects of treatment but yields could not be taken. (Contribution by the Experimental Farm Lacombe, Alberta.)

**Cultural control of green foxtail. Keys, C. H.** Seven duplicated post-seeding cultural treatments were applied to wheat on stubble for the control of green foxtail. Pre-seeding tillage was uniform and consisted of ploughing, packing and seeding with a press drill. A summary of the results are as follows:

| Seeding time | Treatment | 1958 Wheat yield bu/A | 1958 Weed score % | Av. 1955-58 Wheat yield bu/A | Av. 1955-58 Weed score % |
|---|---|---|---|---|---|
| 1 Normal | Pre-emerg. rodweed | 9.0 | 96 | 12.6 | 96.4 |
| 2 Normal | Pre-emerg. harrow | 5.9 | 92 | 11.7 | 96.4 |
| 3 Normal | Post-emerg. harrow | 6.5 | 85 | 14.2 | 77.2 |
| 4 Normal | Pre-emerg. rodweed post-emerg. harrow | 7.0 | 85 | 14.0 | 80.6 |
| 5 Normal | Check | 9.3 | 100 | 13.7 | 100.0 |
| 6 Delayed | Check | 7.8 | 88 | 14.8 | 81.2 |
| 7 Delayed | Pre-emerg. rodweed post-emerg. harrow | 7.7 | 92 | 14.2 | 95.8 |

Growth of both crop and weeds was very light as the crop yields indicate. The differences between treatments were so small that for all practical purposes they were non-existent. Over the past four years control by the cultural methods used has been of small consequence. Post-emergence harrowing has, at times, given a reasonable degree of control but results have not been consistent. (Contribution from Experimental Farm, Scott, Saskatchewan.)

**Control of green foxtail with chemicals. Keys, C. H.** An area of wheat stubble, heavily and uniformly infested with green foxtail, was plowed, packed and sown to flax in early June. On June 26, when the foxtail and flax were about 3 inches high, randomized and replicated plots were treated with TCA at 1, 2, 4 and 6 lb/A and dalapon at ¼, ⅜, ½, ¾, 1 and 1½ lb/A. Two untreated plots were included in the test. All treatments were applied in water at 10 gal/A and a blanket treatment of 4 oz/A of 2,4-D amine. A very poor stand of flax was obtained, thus yields were not taken. The foxtail infestation was very uniform and in spite of extremely dry conditions for most of the growing season reasonably good control was obtained. An analysis of the weights of dry weeds showed that the 1 and 1½ lb/A rates of dalapon and the 4 and 6 lb/A rates of TCA gave kills that were highly significant. The kills from the 2 lb/A rate of TCA and ¾ lb/A rate of dalapon were significant at the 5% level. Visually the ½ lb/A rate of dalapon was equal in effect to the ¾ lb/A rate but the analysis did not uphold this observation. The light rates of either chemical were not effective although some stunting was observed. (Contribution from the Experimental Farm, Scott, Saskatchewan.)

**The effect of date of cultivation on the germination of wild oat seeds. McCurdy, E. V.** Plots severely infested with wild oats have been worked at different dates in the fall or spring for the past three years. The dates of disking were as follows: September 20, October 5, October 20, October 20 and early spring (April 15 in 1958), early spring only, and just before seeding only. The plots have been sown to barley continuously. Disking the plots on September 20 and October 5 has resulted in a lower weed count in the crop than when work was delayed until spring. In both plots where early spring work was carried out this year, irrespective of whether worked in the fall or not, the weed count was higher. The count per square yard in the crop in 1958 and the 3-year average are as follows: Disked September 20, 1.5 and 6.0; October 5, 1.5 and 5; October 20, 3.2 and 13; October 20 and early spring. 6.7 and 15; early spring only, 7.2 and 20; and just before sowing, 2.8 and 14.0. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

**Preplanting control of wild oats. McCurdy, E. V.** Three chemicals, M-1112 (1,2,4,5-tetrachlorobenzene) at 15 lb/A, CIPC at 15 lb/A, and EPTC at 10 lb/A, were applied to soil containing a known number of wild oats. Flax was sown the same day the chemicals were incorporated in the soil. Neither flax nor wild oats plants emerged in any of the plots treated with CIPC at the above rate. With M-1112 about 15% control resulted with about the same injury to the flax. EPTC completely prevented the growth of wild oats. Approximately the same number of flax plants emerged as in the checks but by fall in the treated plots the number of normal plants had decreased by 66%. Although drought resulted in a slight reduction in the checks, the reduction was much less than in the EPTC plots, even though the latter had no weed competition. With this group of chemicals, wherever wild oat control was noted, injury to the flax crop was so extensive that it would not be safe to use these chemicals immediately before seeding. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

**Preplanting chemicals for control of wild oats. McCurdy, E. V.** A number of chemicals were disked into the soil on May 18, 1958: CIPC at 10 and 15 lb/A, EPTC at 5 and 10 lb/A, CDAA at 4 and 8 lb/A, simazin at 4 and 8 lb/A and 3Y9 [tris-(2,4-dichlorophenoxyethyl) phosphite] at 8 lb/A. Wild oat plant counts were taken in each plot in the fall. CIPC at 10 and 15 lb/A averaged 7 and 6.2 plants per plot; EPTC at 5 and 10, 14 and 10; CDAA at 4 and 8, 24 and 18; simazin at 4 and 8, 29 and 15; 3Y9, 19; and the check 44. This indicates a fair degree of control with CIPC and EPTC. Barley and flax were sown across each plot two weeks after the treatment. Estimates of stand following each of the above treatments were as follows: CIPC, barley 50 and 34%, flax 30 and 6%; EPTC, barley 75 and 20%, flax 75 and 60%; CDAA, barley normal and 75%, and flax normal; simazin, barley 50 and 30% and flax 60 and 40%; 3Y9, barley normal and flax 45%. In every case where a fair degree of control of wild oats was noted, except with the light rate of EPTC, injury to the crop was so severe that these chemicals should not be recommended at the rates tested. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

**Chemicals for wild oat control in the summerfallow year. McCurdy, E. V.** 1,2,4,5-tetrachlorobenezene (M-757) was applied to a group of plots in the early summer of 1957 at rates of 10, 20, 25 and 30 lb/A. In order to observe wild oats growth, the plots were not sown to a crop in 1958. Because of lack of rainfall, emergence of wild oats was not as heavy as in most seasons. The average number of wild oats counted on the plots in late summer was as follows: Check, 11; 30 lb/A, 3; 25 lb/A, 6; 20 lb/A, 9; and 10 lb/A, 6. The heavy rate of this chemical resulted in a fair degree of control. In another part of this project M-757 was incorporated in the soil by three different methods. Plots were one-wayed once, one-wayed twice or rototilled. One-waying twice resulted in the best control. Packing did not improve the effectiveness of the chemical. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

**The effect of crop competition on the number of wild oats in the crop. McCurdy, E. V.** Barley has been sown on summerfallow for the past three years at two dates, at two rates (1½ and 3 bu/A), with and without fertilizer (50 lb/A 11-40-0). At the early date (May 15, 1958) when the crop was sown at 1½ bu/A the wild oat plant count per square yard amounted to 48 and at 3 bu/A, 26. When fertilizer was applied with the light rate the number of wild oats decreased to 23 and with the heavy rate to 18 —a progressive decrease as the competition was increased. At the late date (May 22) all plots had a count of less than one plant per square yard irrespective of the treatment. The average yield of all barley plots at the early date this year was 24.5 bu/A and at the late date 38.5 bu/A. One hundred wild oat plants were taken from each plot, threshed and the seed weighed. The weight of seed from the light rate without fertilizer was 41.5 gm, fertilized 33.5 gm; the heavy rate of seeding, without fertilizer 32.0 gm and with fertilizer 26.8 gm. This indicates that additional competition not only decreased the number of plants but also the seed produced per plant. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

**The effect of quantity of stubble cover on the germination of wild oat seeds in the field. McCurdy, E. V.** The treatments consisted of plots with a normal stubble cover; plots where one ton of stubble was added to simulate a heavy combine stubble; where 100 and 200 lb/A of Cyanamid were applied; and where the stubble was



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removed by burning. Half of each group of plots was disked in the fall and the others were left unworked. Wild oat plant counts were taken during the summerfallow year, in the crop year before seeding and in the the crop before harvest. Fall disking stimulated early spring growth of wild oats; the addition of nitrogen in Cyanamid did not result in enough additional growth to justify the treatment. Less growth was noted in the early spring on the plots that were burned, particularly those left unworked in the fall. The wild oat count was the highest in the crop following the heavy combine stubble and the lowest in the crop following burning, but there was not enough difference to justify this latter practice. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

**Annual smartweed control in spring oats. Rogers, B. J.** Small grain breeders prefer not to use 2,4-D in their nurseries. In a search for other herbicides which could be used to control a serious infestation of *Polygonum pennsylvanicum* we tried amitrol at ½, 1, 2, 4, and 8 lb/A and diuron at ½, 1, and 1½ lb/A in 30 gpa of water. Treatments were made on Newton oats; oat height was 4-5 in, smartweed height 1-3 in. At ½ lb neither chemical was effective. Diuron at 1 and 1½ lb resulted in 60-70 percent control with apparent injury to the oats. Amitrol at 1 lb resulted in 60 percent control; at 2, 4, and 8 lb, 90-95 percent. These rates of amitrol caused chlorosis and leaf burn in the oats; at 1 and 2 lb there was complete recovery, at 4 lb 80-90 percent recovery, and at 8 lb 30 percent recovery. Data are based on a visual estimate. (Department of Botany and Plant Pathology, Agricultural Experiment Station, Purdue University).

**Tartary buckwheat control in wheat, 1958. Selleck, G. W.** The butyl ester of 2,4-D and a mixture of 93% isopropyl amine salt of 2,4-D, 7% isopropyl amine salt of citric acid (Diax) at initial rates of 8 lb/A and a mixture of chlorinated benzoic and cresoxyacetic acids (Fisons 1815) at an initial rate of 10 lb/A were applied in 35 gal water with a variable rate sprayer to tartary buckwheat in Chinook wheat on silty-clay loam soil at Saskatoon. The treatments were applied June 6 to duplicated, 5 x 95 ft plots when the wheat was in the 3-leaf stage and the buckwheat was 2 inches high. 2,4-D, Diax and Fisons 1815 killed 85% of the tartary buckwheat at rates of 2.4, 1.8, and 2.2 lb/A, respectively. Satisfactory control was obtained by 8 oz/A of 2,4-D and 1 lb/A each of Diax and Fisons 1815. The wheat was delayed by 4 lb/A of 2,4-D and 1.3 lb/A of Fisons 1815. Diax at an 8 lb/A rate had no visible effect on wheat. 2,4-D which was applied to wheat before and after a severe spring frost, affected the crop to a similar degree. (Contribution from the Department of Plant Ecology, University of Saskatchewan, wtih financial assistance from the Monsanto Chemical Co.)

**Post-emergence applications in wild oat control, 1958. Selleck, G. W.** *N*-(2,6-dimethylphenyl)-alpha-chloroacetamide (M-625) and 4-chloro-2-butynyl *N*-(3-chlorophenyl)carbamate (S-847) were applied to natural infestations of wild oats in barley and wheat on silty clay loam soil near Saskatoon. M-625 was applied to wild oats, wheat and barley when these plants were in the 3-leaf stage. S-847 was applied in the 4-leaf and boot stages. The herbicides were applied with a variable rate sprayer in duplicated, 5 x 135 ft plots at initial rates of 18 lb/A M-625 and 5 lb/A S-847. S-847 initially provided 95% control of wild oats at a rate of 2.6 lb/A and stunted the barley at a rate of 6 lb/A when applied at the 4-leaf stage. This apparent control was not visible after a 3 in rain which fell in July. The stunted wild oat population continued its development and produced seed. Wheat was delayed slightly at the 2.5 lb/A rate. When applied at the boot stage, the herbicide had little effect on wild oats, but severely damaged wheat heads at a rate of 1.25 lb/A. A-625 appeared to have no detrimental effects on wheat or wild oats at the 18 lb/A rate, or on rapeseed when applied in the 4-leaf stage. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from Amchem Products, Inc.)

**Various herbicides for wildoats control, 1958. Selleck, G. W.** Various herbicides were applied May 28 with a variable rate sprayer to a natural infestation of wild oats on loam soil near Spalding, Sask. The herbicides were applied at initial rates of 16 lb/A in 16 gal of water on duplicated, 15 x 155 ft plots and incorporated into the soil with two operations of the oneway. The area was sown to barley three days later. The percentage control (reduction in stand) of wild oats and barley are listed in the following table. The data are presented in fraction, with the numerator representing the rate (lb/A) and the denominator representing the resulting percentage control.

| Herbicide | Species | | | | | |
|---|---|---|---|---|---|---|
| | Wild oats | | | Barley | | |
| EPTC | 3/100 | 2/99 | 1.6/95 | 2.3/0 | 3/15 | 5.3/50 |
| Simazin | 2.2/95 | 1.5/60 | | 1.1/0 | 1.5/35 | 1.8/85 |
| CDAA (solventless) | 11.5/50 | | | 16/0 | | |
| CDAA | 11.5/50 | | | 16/0 | | |
| TBA | 7.9/50 | | | 2/85 | | |
| DCU | 11/50 | | | 5.5/50 | 2.6/10 | |

No visible control of wild oats or damage to barley was visible at rate up to 16 lb/A of the following herbicides: 3Y9 [tris-(2,4-dichlorophenoxyethyl) phosphite], and CDT. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Monsanto Chemical Company.)

**Wild oat control in rapeseed, 1958. Selleck, G. W.** CDAA, CIPC, IPC, simazin, EPTC, solventless CDAA, DCU and CDT at initial rates of 16 lb/A in 35 gal of water were applied to artificial wild oat infestations on silty clay loam soil with a variable rate sprayer May 9, 1958. The plots were double disked immediately and seeded to Argentine rapeseed the next day. The control of wild oats and the effect on the rapeseed by various herbicides is given in the following table. The data are presented as a fraction, the numerator representing the rate of application (lb/A) and the denominator the resulting percent control, or retardation.

| Herbicide | Wild oats | | Rape |
|---|---|---|---|
| CDAA | 10 / 95 | 4 / 75 | 8 / delayed 2-3 days |
| CIPC | 2.7 / 100 | 1 / 90 | 8.3 / delayed 2-3 days |
| IPC | 4 / 100 | 1 / 85 | 4.1 / delayed 1 week |
| Simazin | 2.9 / 100 | 1.3 / 95 | 1 / 30 |
| EPTC | 4 / 100 | 1 / 95 | 5.5 / delayed 2-3 days |
| CDAA, and Solventless CDAA | 8 / 80 | — | 4 / delayed 2-3 days |
| DCU | 8 / 80 | — | 5 / delayed 2-3 days |
| CDT | No control | | 8 / delayed 2-3 days |

Simazin, IPC and CIPC were applied to an artificial infestation of mustard in rapeseed. CIPC at 7 lb/A provided 85% control of wild mustard and stinkweed and the 8.3 lb/A rate delayed the maturity of the rapeseed for a period of two days. IPC and simazin controlled 85% of the mustard at rates of 8 and 3.2 lb/A, respectively. The rapeseed appeared to be more susceptible to these herbicides than the mustard. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Monsanto Chemical Co.)

**Post-emergence applications of herbicides on rapeseed, 1958. Selleck, G. W.** Dalapon, TCA, and TBA at

10 lb/A, and MCPB, 2,4-DB, amine salt of 2,4-D, sodium salt of MCPA, and Diax (93% isoproylamine salt of 2,4-D, 7% isoproylamine salt of citric acid) at 4 lb/A, initial rates, were applied to weeds in Argentine rapeseed June 23, 1958, on silty clay loam soil at Saskatoon. The herbicides were applied in 35 gal/A of water to duplicate 15 x 135 plots. Dalapon and TCA killed 95% of green foxtail at rates of 2.5 and 4 lb/A, respectively. TCA appeared to have no adverse effect on the rapeseed, while dalapon delayed the crop two or three days at a rate of 1 lb/A. TBA gave 100% control of Russian thistle at 2.1 lb/A and 95% at 1.5 lb/A, damaging the rapeseed at a rate of 4 oz/A. Green foxtail was not adequately controlled. The following table summarizes the effect of systemic herbicides in the control of mustard, rapeseed, and Russian thistle. The numerator represents the rate (lb/A) and the denominator represents the resulting percentage control.

| Species | Herbicide | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MCPB | | 2,4-DB | | 2,4-D | | Diax | | MCPA | |
| Russian thistle | 2.4 | 1.3 | 1.6 | 0.5 | 1.2 | 0.9 | 0.9 | 0.8 | 2.0 | |
| | 100 | 90 | 100 | 95 | 100 | 95 | 100 | 95 | 95 | |
| Rapeseed and Mustard | 0.6 | 0.4 | 1.6 | 0.4 | 1.1 | 0.9 | 1.2 | 1.0 | 2.0 | 1.3 |
| | 100 | 90 | 100 | 90 | 99 | 85 | 100 | 95 | 100 | 80 |

Rapeseed appeared normal after application of various herbicides at the following rates: MCPB—1.3 oz, MCPA —1.3 oz, 2,4-DB—1.9 oz, 2.4-D—2.5 oz and Diax—8.0 oz. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**Herbicides for annual weed control, 1958. Selleck, G. W.** TBA at an initial rate of 24 lb/A in 1957 and 12 lb/A in 1958 and FB-2 (1,1'-ethylene-2,2'-bipyridinium dibromide) at an initial rate of 5 lb/A with a spreader-activator (X-77) were applied with a variable rate sprayer to annual weeds in silty clay loam soil at Saskatoon. HCA at an initial rate of 96 lb/A was also applied with a diesel fuel carrier. Granular materials simazin at 2, 4, and 6 lb/A and EPTC at 4, 8 and 12 lb/A were applied with a 4-ft Gandy spreader. TBA, EPTC and simazin were applied May 20, 1958 and incorporated into the soil with a double disc. The other herbicides were applied to weeds when they had reached a height of 6 in. The results are presented in the table. The rate of application (lb/A) is reprsented in the numerator of a fraction, the resulting percentage control in the denominator.

| Herbicide | Species | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Portulaca oleracea* | | *Amaranthus retroflexus* | | *Thlaspi arvense* | | *Salsola pestifer* | | *Chenopodium album* | |
| TBA (1958) | 4.8 | 2.2 | 6.6 | 1.8 | 6.0 | 3.0 | 6.0 | 1.3 | 1.8 | 0.7 |
| | 95 | 85 | 100 | 90 | 100 | 90 | 100 | 90 | 100 | 100 |
| TBA (1957) | 8.6 | 5.1 | 7.2 | 3.8 | 7.5 | | 7.1 | 3.1 | 3.3 | 1.4 |
| | 99 | 80 | 100 | 95 | 90 | | 100 | 95 | 100 | 80 |
| Simazin granular | 4 | 2 | 6 | | 4 | 2 | 6 | | 4 | 2 |
| | 95 | 90 | 70 | | 95 | 50 | 50 | | 100 | 90 |
| EPTC granular | 6 | 4 | 12 | | 6 | | 12 | | 8 | 4 |
| | 99 | 90 | 80 | | 95 | | 50 | | 100 | 70 |

FB-2 maintained 85% control of *Descurainia sophia* and *Thlaspi arvense* at a rate of 1.8 lb/A. HCA provided 99% control of the same species at a rate of 58 lb/A. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**Control of low amaranth and purslane, 1958. Selleck, G. W.** Butyl esters of 2,4-D, MCPA, MCPB, and 2,4-DB, mixed esters of 2,4,5-T, low volatile ester of 2,4-D (ACP 129), and a mixture of 93% isopropyl amine salt of 2,4-D, 7% isopropyl amine salt of citric acid (Diax) at initial rates of 8 lb/A; neburon and 3-(3,4-dichlorophenyl)-1,1-diethylurea at 16 lb/A; and mixed chlorinated benzoic and cresoxyacetic acids (Fisons 1815) at 10 lb/A; (initial rates) in 35 gal water, were applied with a variable rate sprayer to purslane and low amaranth in Chinook wheat in duplicated, 15 x 135 ft plots June 13, 1958. Most of the weeds had just emerged. The weeds were controlled 100% with herbicides at the following rates (lb/A): 2,4-D, 5; MCP, 1.7; ACP 129, 1.4; MCPB, 1.7; 2,4-DB, 5.8; and 2,4,5-T, 2.2. Neburon and the other urea compound controlled purslane with rates of 3.7 lb and 2.9 lb, respectively, and appeared to have little effect on low amaranth. Diax had little effect on either species. None of the herbicides appeared to have any noticeable effect on Chinook wheat with the exception of 2,4-D ester in excess of 4, and ACP 129 in excess of 2 lb/A. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from Amchem Products, Inc.)

**Herbicides for hemp nettle control in wheat, 1958. Selleck, G. W.** MCPA butyl ester and a mixture of 93% isopropyl amine salt of 2,4-D and 7% isopropyl amine salt of citric acid (Diax) at 8 lb/A, a mixture of chlorinated benzoic and cresoxyacetic acids (Fison 1815) at 10 lb/A and neburon and 3-(3,4-dichlorophenyl)-1,1-diethylurea at 16 lb/A initial rates were applied in duplicate to 15 x 135 ft plots with a variable rate sprayer to hemp nettle in Chinook wheat on silty clay loam soil near Saskatoon June 6, 1958. The wheat was in the 3-leaf stage and hemp nettle was 2 to 3 in high. Hemp nettle was satisfactorily controlled by MCPA ester at 0.5, Fisons 1815 at 2.7, and Diax at 3.5 lb/A. The urea derivatives had no visible effect on the wheat or the hemp nettle. 2.2 lb of Fisons 1815 and 7 lb of MCPA delayed the wheat. (Contribution from the Department of Plant Econolgy, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**Tetrachlorobenzene for wild oat control, 1958. Selleck, G. W.** 1,2,4,5-tetrachlorobenzene (M-757, 50% 1,2,4,5-tetrachlorobenzene—at 12, 21 and 24 lb/A, and M-1112, 20% active, at 8, 14 and 16 lb/A) (all rates active) were applied to a natural infestation of wild oats on silty clay loam soil near Saskatoon, October 18, 1957. The herbicides were applied to duplicated, 19 x 150 ft plots. The application was made with a 4 ft Gandy spreader and one-half of the plot was single-disced, the other half double-disced, immediately after application. The field was seeded to wheat in the spring of 1958. Good wild oat control was obtained with M-757 at 21 lb/A and M-1112 at 16 lb/A where the plots were double disced. These rates, however, caused considerable damage to the wheat. The percentage control (decrease in stand) for wheat and wild oats is presented in the table.

| Herbicide | Rate lb/A | Percentage control | | | |
|---|---|---|---|---|---|
| | | Double disced | | Single disced | |
| | | Wheat | Wild oats | Wheat | Wild oats |
| M-757 | 12 | 7 | 30 | 10 | 60 |
| | 21 | 78 | 95 | 65 | 57 |
| | 24 | 65 | 57 | 35 | 25 |
| M-1112 | 8 | 13 | 50 | 12 | 25 |
| | 14 | 55 | 67 | 52 | 40 |
| | 16 | 78 | 92 | 60 | 55 |

(Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**Granular herbicides in wild oat control, 1958. Selleck, G. W.** Simazin at rates of 1.7, 2.4 and 4.1 lb/A,



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EPTC at 1, 2 and 3 lb/A, CDAA at 3, 4 and 6 lb/A, 1,2,4,5-tetrachlorobenzene (M-1294, 20% 1,2,4,5-tetrachlorobenzene at 12, 18 and 24 lb/A and M-1112, also 20% active, at 7, 10 and 14 lb/A) (all rates active) were applied with a 4-ft Gandy spreader on duplicate, 15 x 135 ft plots to natural infestations of wild oats on loam soil near Spalding, Sask., May 28. The herbicides were double-disced within one hour of application, and the area was sown to barley within four days. The percentage decrease in stand of wild oats and barley at various rates (lb/A) are presented in the table.

| Species | Simazin | | | EPTC | | | M-1294 | | | M-1112 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.7 | 2.4 | 4.1 | 1 | 2 | 3 | 12 | 18 | 24 | 7 | 10 | 14 |
| Wild oats | 0 | 20 | 50 | 95 | 100 | 99 | 60 | 75 | 90 | 40 | 30 | 75 |
| Barley | 0 | 0 | 30 | 10 | 50 | 70 | 5 | 60 | 75 | 10 | 0 | 40 |

Although the stand of barley was reduced by 10% with the 1 lb/A rate of EPTC, the yield was substantially increased over that of the check. CDAA had no visible effect upon either barley or wild oats. In another test, CDAA granular at 4 lb/A was applied with a double-disc drill into the soil (through the fertilizer attachment), during the seeding operation. Approximately 75% of the barley failed to germinate but was replaced by a good stand of volunteer wheat. (Contribution from the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Monsanto Chemical Company.)

**Herbicides for chemical summerfallow, 1958. Selleck, G. W., White, W. J., and Gerrie, H.** The butyl ester of 2,4-D at 8 lb/A, EPTC at 16 lb/A, Zytron (20% silvex, 80% dalapon) at 20 lb/A, FB-2 (1,1'-ethylene-2,2'-bipyridinium dibromide) at 5 lb/A and EPTC, 3Y9, simazin and TBA at 16 lb/A, initial rates, were applied with a variable rate sprayer to weeds on silty clay soil May 27, 1958 at Saskatoon. Plots treated with EPTC, 3Y9, simazin, and TBA were double disced within an hour of application. The species present included lambsquarters, low amaranth, redroot pigweed, stinkweed, purslane, blue bur, and flax. Two applications of 2,4-D ester maintained 100% control all summer at 2.4 lb/A and 95% at 1.4 lb/A, without requiring tillage. Single applications of EPTC and 3Y9 at rates between 16 and 2.4 lb/A provided 75% control. Simazin also provided 100% control at 1.3 and 50% control at 0.8 lb/A. A single application of TBA controlled all weeds 100% at a rate of 1.9 lb/A, 95% at 1.7 lb/A, and 50% at 1.4 lb/A. Zytron provided satisfactory top growth control at a rate of 13 lb/A, and FB-2 controlled top growth of all weeds at a rate of 3 lb/A. Redroot pigweed, lambsquarters and Russian thistle were controlled at the 1 lb/A rate. The addition of a spreader-activator (X-77) at a rate of 1.25 cc in 1000 cc of solution did not appear to improve the results over FB-2 used alone. (Contribution of the Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**Pre-emergence application of EPTC to control Setaria, lambsquarters and wild mustard in flax, corn, soybeans and sugar beets. Zinter, C. C.; Amstrup, C. R.; Slough, A. T.** Applications of 8, 4, 2 and 1 lb/A in 10 gal water were made at Halstad, Minnesota, in triplicate May 27, 1958; crops were seeded May 26, 1958. Additional triplicate applications of 8 and 4 lb/A were incorporated with a springtooth harrow immediately following sprayer. Final observations July 22 were as follows:

8 lb/A unincorporated: Setaria 95% killed; mustard and lambsquarters set back severely. Flax, sugar beets, corn not injured. Soybeans 70% stand reduction.

8 lb/A incorporated: Same.

4 lb/A unincorporated: No significant weed control or crop damage.

4 lb/A incorporated: 90% Setaria control; mustard and lambsquarters set back. Corn, sugar beets, flax no visual injury; soybeans 70% stand reduction.

2 and 1 lb/A: No weed control; no crop damage.
No yields taken. (Contribution of F. H. Peavey & Co., Minneapolis, Minnesota.)

**Pre-emergence application in 1955, 1956, 1957 and 1958 of CDAA to control Setaria and wild oats in small grain, corn, soybeans and flax. Binter, C. C.; Amstrup, C. R.; Slough, A. T.** Triplicate applications of 6 and 3 lb/A active ingredient in 1955; 4 and 2 lb/A active ingredient in 1956 and 1957; and 12, 6 and 3 lb/A active ingredient in 1958 were made at Halstad, Minnesota. In all years, water was used so as to apply 10 gal/A of solution. 1955 applications were made April 29 (2 days after seeding); soil was dry and remained dry for three weeks; from then till heading, moisture was excessive. Weather was cool during the first three weeks. Visual comparisons indicated little, if any, control of wild oats or Setaria or any crop injury at either rate of application. Triplicate applications were made May 29, 1956 (day after seeding) and May 24, 1957 (seeding date). Moisture was plentiful to excessive at time of application and remained so during most of growing season. Visual observations in 1956 and 1957 indicated good Setaria and wild oat control for 6-8 weeks with both 4 and 2 lb rates. Rough pigweed and mustard were controlled for 4-6 weeks. Crops were not injured at either 4 or 2 lb rates. Triplicate applications were made May 27, 1958 (day after seeding). Soil moisture conditions were good at time of seeding; growing conditions were good all season. Final observations were made July 22. 12 lb/A killed all Setaria. Wheat, barley, and oats suffered 50% stand reduction; corn, soybeans and flax were not injured. 6 lb/A gave 98% Setaria control. Crop reaction was visually the same as for 12 lb/A. 3 lb/A gave 98% Setaria control, and no crop injury. Wild oat population was not adequate for valid testing. (Contribution of F. H. Peavey & Co., Minneapolis, Minnesota.)

## WEED CONTROL IN FIELD CROPS
## SPRING SOWN GRAIN

**Amitrol on oats. Bondarenko, D. D.** Triplicate plots, 5 x 50 feet, (var. Garry) at the late jointing stage were treated with amitrol at 4 and 8 lb/A in 40 gpa water on June 55, 1958. At maturity no damage to the oats was evident in any of the plots. (The Ohio Agricultural Experiment Station.)

**Comparison of 2,4-D, MCPA, 2,4-DB, MCPB, and a mixture of chlorinated benzoic and cresoxyacetic acids (Fisons 1815) for weed control in wheat, oats, barley and flax. Brown, D. A.** Esters of 2,4-D and MCPA and F1815 were applied at 4 and 6 oz/A, esters of 2,4-DB and MCPB at 16 and 24 oz/A, and amines of these latter two at 20 and 30 oz/A. Cereal crops were sprayed when 5 inches high, flax when it was 3 inches. Extremely dry weather prevailed throughout the growing season. Crops were grown on stubble land. Weeds prevailed. Wheat and barley showed a high tolerance to all formulations at all rates with the exception of F1815 from which yields were slightly but not significantly lower. Oats developed onion leaf and stunted growth at the higher rates of 2,4-D and 2,4-DB esters and some injury was apparent from F1815, but yields were not significantly reduced. Flax yields were significantly reduced only by the 2,4-DB ester. Damage from this compound at both the 16 and the 24 oz/A rates was considerable. Prevailing weeds were: lambsquarters, redroot pigweed, wild buckwheat, stinkweed, Russian thistle and green foxtail. Percentage overall control is shown in the table below:



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| Chemical oz/A | 2,4-D ester 4 | 2,4-D ester 6 | MCPA ester 4 | MCPA ester 6 | 2,4-DB ester 16 | 2,4-DB ester 24 | 2,4-DB amine 20 | 2,4-DB amine 30 | MCPB ester 16 | MCPB ester 24 | MCPB amine 20 | MCPB amine 30 | F1815 4 | F1815 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average percent control all weeds | 68 | 84 | 54 | 79 | 78 | 91 | 69 | 84 | 73 | 89 | 73 | 88 | 71 | 86 |

(Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba).

**The effect of heavy dosages of 1,2,4,5,-tetrachlorobenzene (M-757) on wild oats and grain crops planted the following year. Friesen, H. A.** 1,2,4,5-tetrachlorobenezene (M-757) was sprayed at the very heavy rates of 25, 60, 62.5 and 75 lb/A on land heavily infested with wild oats. The treatments were applied in July of 1957 while the land was being summerfallowed. All treatments prevented any further emergence of wild oats in 1957. Wild oats seeds were sifted from the top 4 inches of the treated soil in the fall of 1957. Germination trials during the winter showed that the killing was achieved by the herbicides' action on the germinating seedlings with little or no effect on the dormant seeds. In late May of 1958 the plots were sown to flax and barley. Plant counts showed that plots treated with M-757 at rates of 50 lb/A or higher reduced the stand of flax by 20% while the stand of barley was reduced by 20% at the 62.5 lb/A rate and by 30% at the 75 lb/A rate. M-757 at 25 and 50 lb/A reduced the numbers of wild oats plants by 20%, the 62.5 lb/A rate resulted in a 50% reduction and the 75 lb/A rate gave a 66% reduction in wild oats plants. (Contributed by the Experimental Farm, Locombe, Alberta)

**Post-emergence spraying with 4-chloro-2-butynyl *N*-3-chlorophenylcarbamate (S847) for wild oats control. Friesen, H. A.** (S-847) was sprayed at three stages of growth on wheat very heavily infested with wild oats. At Date 1 the wild oats and wheat were mostly in the 2-leaf stage and the dosages of S-847 used were 4, 8, and 16 oz/A. At Date 2 the wild oats were in the 3-leaf stage and the rates used were 4, 8, 16 and 32 oz/A. S-847 at these rates was also applied when the wild oats were in the early shot blade stage, Date 3. Water at 6 gal/A was used as a carrier for all treatments.

Dry weight of wild oats produced was 0, 66, and 78 percent lower than on the untreated check following spraying with S-847 at 4, 8, and 16 oz/A, respectively, at Date 1. At Date 2 the chemical at rates of 4, 8, 16, and 32 oz/A reduced the dry weight of wild oats by 32, 60, 86 and 84 percent, respectively. The greater reduction in wild oats at Date 2 may be ascribed in part to the further emergence of wild oats following treatment at Date 1. The production of wild oats seeds was reduced by almost 80% where the 16 and 32 oz/A rates were applied at Date 2. The herbicide had a marked effect on the wheat in the early growth stages following treatment at both dates. However, at harvest time only the treatments made at Date 1 depressed the wheat yield. At Date 2 all treatments, except the 32 oz/A rate, increased the wheat yield. At Date 3 there was no effect on either the wild oats or the wheat. (Contributed by the Experimental Farm, Lacombe, Alberta.)

**The effect of 2,4-D and amitrol on Canada thistle, 1958. Selleck, G. W.** 2,4-D butyl ester at 8 lb/A and amitrol at 20 lb/A initial rates were applied to Canada thistle September 13, 1957, on duplicate 15 x 135 ft plots on silty clay loam soil. The herbicide was applied in 35 gal/A of water. The summerfallow had been tilled twice previous to treatment, and the weed had reached the bud stage at the time of application. The field was seeded to wheat the spring of 1958. In October, 1957, 2,4-D at 3.4 lb/A and amitrol at 3 lb/A killed all top growth of Canada thistle. Tops were killed by these herbicides at rates as low as 4 oz/A but a few green stem-leaves remained. On July 24, 1958 little effect was visible on the stand of Canada thistle even at the 8 lb/A rate of 2,4-D. Amitrol at 10 to 20 lb/A maintained 75% control. A combination of 2.6 oz 2,4-D and 4 oz amitrol killed all top growth in October, 1957. Ninety percent control was maintained in July, 1958 with a combination of 5 oz 2,4-D and 1.2 lb amitrol. Wheat was delayed and decreased in stand by the 10 lb/A rate of amitrol. (Contribution from the Department of Plant Ecology, University of Saskatoon, with financial assistance from Amchem Products, Inc.)

## FALL SOWN GRAIN

**Effect of 2,4-D on baking quality of irrigated Concho wheat. Wiese, A. F. and Rea, H. E.** One pound of propylene glycol butyl ether ester of 2,4-D applied to Concho wheat when it had 2-3 leaves, 2-3 tillers, 6-8 tillers, 15-20 tillers, or was fully tillered, did not appreciably affect the protein or over-all milling or baking quality of the wheat. However, loaf volume was reduced as compared to an untreated check. Where loaf volume was reduced, grain and texture of the loaf improved; consequently, the over-all baking score was not changed. The total baking score of the untreated check was 57 which is considered poor. The 2,4-D caused significant yield reductions at all stages of application. The untreated check yielded 21.3 bushels per acre and the poorest yield, 15.8 bushels, occurred where the 2,4-D was applied to wheat with 6-8 tillers. The LSD at the 5% level was 2.7 bushels per acre. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agricultural Experiment Station and USDA, cooperating.) (Approved as TAES T. A. 3044.)

## SORGHUM

**Effect of several pre-emergence herbicides used for weed control in Midland grain sorghum. Phillips, W. M.** The following chemicals were applied pre-emergence on June 22, 1957, to Midland grain sorghum planted June 20: simazin at 2 and 4 lb/A; 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine, 2-chloro-4,6-bis-(isopropylamino)-*s*-triazine, 2-chloro-4-diethylamino-6-isopropylamino-*s*-triazine, 2-methoxy-4,6-bis-(ethylamino)-*s*-triazine, and 2-chloro-4-*n*-propylamino-6-isopropylamino-*s*-triazine at 4 and 8 lb/A; isopropyl ester of 2,4-D, polychlorinated benzoic acid (PBA), and monuron at 1 and 2 lb/A. The experimental design was a randomized block with four replications. Rain fell on 5 of the 10 days before treatment and on 6 of the 10 days after treatment. The weed population consisted almost entirely of rough pigweed. The high rate of all chemicals and both rates of simazin, 2-chloro-4-*n*-propylamino-6-isopropylamino-*s*-triazine, 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine, and the ester of 2,4-D adversely affected the crop at or shortly after emergence. Of the remaining treatments only 4 lb/A of 2-chloro-4,6-bis-(isopropylamino)-*s*-triazine and 2-chloro-4-diethylamino-6-isopropylamino-*s*-triazine resulted in relatively satisfactory weed control and little adverse effect on the crop. Average yield of hand-weeded plots was 60.5 bu/A. Plots receiving no weed control yielded 42.5 bu/A. Only plots treated with simazin at 4 lb/A and the ester of 2,4-D at 1 and 2 lb/A yielded less than the weedy checks. Other treated plots yielded from 43.4 to 57.2 bu/A. (Contributed by the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Fort Hays Branch of Kansas Agricultural Experiment Station, Hays, Kansas.)

**Effect of 2,4-D and 4-(2,4-DB) on Midland grain sorghum. Phillips, W. M.** Applications of 2,4-D and 4-(2,4-DB) were made in 1957 when Midland grain sorghum was 15 inches tall and the developing floral primordia were about ¼ inch long. Previous experiments indicated that Midland is highly susceptible to



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2,4-D at this stage. The experimental design was a randomized block with 4 replications.

| Treatment | Rate (lb/A) | Yield (bu/A) | Test (lb/bu) |
|---|---|---|---|
| 2,4-D, alkanolamine | ¼ | 26.4 | 55.9 |
| | ½ | 24.2 | 55.8 |
| | 1 | 17.8 | 55.0 |
| 2,4-D, ethyl ester | ¼ | 28.6 | 55.9 |
| | ½ | 27.6 | 55.6 |
| | 1 | 13.2 | 54.0 |
| 4-(2,4-DB), dimethylamine | ½ | 23.2 | 55.8 |
| | 1 | 18.0 | 55.0 |
| | 2 | 8.4 | 53.8 |
| 4-(2,4-DB), mixed butyl ester | ½ | 32.3 | 55.8 |
| | 1 | 21.6 | 55.5 |
| | 2 | 4.6 | 53.8 |
| Hand weed | | 41.7 | 57.0 |
| No weed control | | 30.7 | 56.0 |

The weed population consisted almost entirely of rough pigweed and tumble amaranth. The esters of 2,4-D and 4-(2,4-DB) at ¼ and ½ lb/A, respectively, gave excellent weed control and appeared equal in effectiveness. The amine formulations were somewhat less effective at the same rates. The hand-weeded plots were not weeded before chemical treatment. It appeared that when equal weed control was obtained 4-(2,4-DB) was fully as injurious to sorghum as 2,4-D. (Contributed by the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Fort Hays Branch of Kansas Agricultural State, Hays, Kansas.) Kansas.)

**Annual weed control in sorghum. Rogers, B. J.** RS 610 sorghum was planted in 7-inch rows. Pre-emergence applications of simazin, EPTC, CDAA and the sodium salt of PCP were made. Major weeds were *Digitaria sanguinalis*, *Panicum* spp., *Setaria* spp., *Echinochloa crus-galli*, *Datura stramonium*, *Amaranthus* spp., and *Chenopodium album*. The plots were located on a Chalmers silt loam soil at the Purdue Agronomy Farm, Lafayette, Indiana. Over 21 inches of rain fell in the two months following application. The following list includes the chemical, the rate/A, and the percent stand reduction (as compared with checks) of grasses and broadleaves; simazin, 2 lb/A, 45%, 95%; simazin 4 lb/A, 80%, 100%; EPTC, 3 lb/A, 45%, 0; CDAA, 4 lb/A, 75%, 0; PCP, sodium salt, 20 lb/A, 40%, 70%. Simazin at 4 lb/A and EPTC at 3 lb/A caused moderate to severe injury to the sorghum. CDAA eliminated most of the grasses, which resulted in an abundant growth of broadleaves. (Department of Botany and Plant Pathology, Agricultural Experiment Station, Purdue University).

**Pre-emergence weed control in grain sorghum. Talbert, Ronald E. and Fletchall, O. Hale.** Westland grain sorghum was planted and treated on May 28, 1957 and on May 23, 1958 at Columbia, Missouri on Mexico silt loam soil. The plot size was two 40-inch rows 30 feet long and there were three applications in 1957 and four in 1958. Soil moisture was slightly below optimum at time of treatment on both years, but nearly one inch of rainfall occurred within a week in each year.

Each test included an uncultivated and a cultivated check. Sprayed plots were not cultivated. Weeds infesting the plots included pigweed, smartweed, horse nettle, and crabgrass. Percent soil not covered by weeds was recorded six weeks after planting. An average of the two years' data showed that the uncultivated check gave 4 percent soil not covered by weeds; 3 cultivations gave 88 per cent; neburon at 1, 2 and 4 lb/A gave 31, 66, and 92 percent; 2,3,6-trichlorobenzoic acid (TBA) at 2 lb/A gave 72 percent; amitrol at 8 and 12 lb/A gave 47 and 56 percent; diuron at 1⅛ and 1¾ lb/A gave 85 and 90 percent; sodium salt of PCP at 20 lb/A gave 69 percent; CDAA at 4 lb/A gave 16 percent; and DNBP at 3 lb/A applied early-post emergence gave 48 percent soil not covered. One year's data showed 2,4-D ester at 1 and 2 lb/A gave 17 and 52 percent; DNBP at 6 lb/A gave 35 percent; 2,5-dichloro-3-nitrobenzoic acid (W-503) at 2, 4 and 6 lb/A gave 73, 83, and 93 percent; and amitrol at ¾ lb/A applied early post-emergence gave 24 percent soil not covered. In another test, percent soil not covered by weeds was as follows: uncultivated check, 56 percent; 3 cultivations, 95 percent; simazin at 1, 2, and 4 lb/A, 92, 95, and 95 percent; Chlorazine at 4 and 8 lb/A, 67 and 82 percent; 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine (Trietazine) at 1, 2, 4, and 8 lb/A, 76, 91, 93, and 95 percent; 2-chloro-4-diethylamino-6-isopropylamino-*s*-triazine (G-30031) at 2, 4, and 8 lb/A, 90, 91, and 94 percent, and 2-chloro-4,6-bis-(isopropylamino)-*s*-triazine (Propazine) at 2, 4, and 8 lb/A, 92, 95, and 96 percent.

In 1957, 2,4-D ester, 2,4-D amine, 2,-4-dichlorophenoxyacetamide at 1 and 2 lb/A, and Trietazine at 4 and 8 lb/A were the only treatments that significantly reduced the stand of grain sorghum as indicated by counts taken July 1. In 1958, diuron at all rates, EPTC at 4 and 8 pounds, and all the triazine derived chemicals at the higher rates injured the grain sorghum severely. Only moderate, early stunting of the sorghum was noted with effective rates of Chlorazine, Trietazine, G-30031, and Propazine. Moderate injury to sorghum was also noted from 2 pounds TBA and 6 pounds M-503.

The 1957 grain sorghum yields were: uncultivated check 23 bu/A; 3 cultivations, 41 bu/A; 2,4-D ester at 1 and 2 lb/A, 15 and 18 bu/A respectively; CDAA at 4 lb/A, 10 bu/A; neburon at 1, 2, and 4 lb/, 39, 41, and 52 bu/A; TBA at 1 and 2 lb/A 28 and 38 bu/A; amitrol at 4, 8, and 12 bu/A, 24, 33, and 36 bu/A; diuron at 1⅛ and 1¾ lb/A, 44 and 55 bu/A; DNBP at 6 lb/A, 23 bu/A; DNBP at 3 lb/A applied early post-emergence, 38 bu/A; and sodium PCP at 20 lb/A, 52 bu/A. For the above yields the LSD 5% is 21 bu/A and LSD 1% is 28 bu/A. In the other test, grain yields were: uncultivated check, 59 bu/A; 3 cultivations, 69 bu/A; simazin at 1, 2, and 4 lb/A, 67, 65 and 59 bu/A; Chlorazine at 4 and 8 lb/A, 57 and 61 bu/A; Trietazine at 2, 4, and 8 lb/A, 71, 38 and 64 bu/A; G-30031 at 2, 4, and 8 lb/A 67, 76, 72 bu/A; and Propazine at 2, 4, and 8 lb/A, 66, 66, and 77 bu/A. The LSD 5% is 12 bu/A and LSD 1% is 16 bu/A. (Contribution of the Missouri Agricultural Experiment Station.)

**Pre-emergence weed control in irrigated RS 160 sorghum. Wiese, A. F. and Rea, H. E.** RS 610 sorghum planted on June 14, 1957, in level borders of Pullman silty clay loam soil was treated with the following herbicides one day after planting: tris-(2,4-dichlorophenoxyethyl) phosphite (3Y9) at 1, 2, 4, and 6 lb/A, CDAA at 2 and 4 lb/A, sodium salt of 4-(MCPB) at 4 lb/A, simazin at 2 and 4 lb/A, and monuron at 1 and 2 lb/A. The treatments were triplicated on each of 2 borders. One border was flood irrigated with 3 inches of water immediately after chemical application, and the other was first irrigated when the sorghum was 1 inch tall. Subsequent irrigations were applied to both borders at the same time. Rainfall and irrigation totaled 24 inches during the crop year. On the plots irrigated immediately, weed control was only apparent where sorghum stands were severely reduced, and as a result, the entire area was cultivated one month after sorghum planting. The cultivated check on this part of the study yielded 6060 pounds of grain per acre. 3Y9 at 6, 4-(MCPB) at 4, and simazin at 4 lb/A reduced seed yields more than 2000 lb/A. No significant yield differences occurred on the plots irrigated when the sorghum was 1 inch tall. Very few weeds germinated on this part of the test; therefore, weed control data were not obtained.

In a greenhouse study, 3Y9 and simazin were each applied at ½ and 3 lb/A to 10 seeds of RS 610 sorghum planted in 4-inch pots at planting time, 2 and 4 days later, at sorghum emergence, and when the plants were 2 inches tall. The experimental design was a split plot



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with 3 replications. Data taken were sorghum height at 30 and 45 days after planting, and the number of sorghum plants per pot 45 days after planting. Thirty days after planting all treatments except ½ pounds of 3Y9 applied 2 or more days after planting significantly reduced sorghum height compared to the check. Sorghum height was still reduced 45 days after planting by 2 pounds of 3Y9 applied at planting, and 2 days later, and at all stages of application by 2 pounds of simazin. Sorghum stand was reduced by all treatments except the ½ pound rates applied when the sorghum was 2 inches tall. (Contribution of the Southwestern Great Plains Field Station, Bushland, Texas, Texas Agricultural Experiment Station and USDA, cooperating.) (Approved as TAES T.A. 3045.)

## FIELD CORN

**Herbicides on corn. Bondarenko, D. D. and Dowler, Clyde.** K-62 hybrid corn was planted in 42-inch rows in Hoytville silty clay loam on May 20, 1958 at the Northwest Substation, Hoytville; in a Miami-Brookston silty clay loam on May 26 at Columbus; and in Canfield silt loam on May 29 at Wooster. German millet was sown in all plots to simulate annual grasses. At Hoytville the plots had a natural infestation of smartweed and common ragweed; at Columbus, redroot pigweed and lambsquarters; at Wooster, smartweed, common ragweed, redroot pigweed and lambsquarters. Triplicate 4-row plots, 35 feet long, were band-treated (21-inch bands) over the corn rows with each rate of each herbicide. The rates given are over-all rates within the bands; the amount actually applied was one-half these rates. All herbicides were applied in 40 gal/A water.

Pre-emergence: neburon at 3 and 6 lb/A; diuron at 2 pt/A; CDAA and CDAA( solventless) at 2, 4, and 6 lb/A; 2,3,6-TBA (DuPont), 2,3,6-TBA (Amchem) and EPTC at 2 and 4 lb/A; CDAA plus PGBE ester of 2,4-D at 2 + 1 and 3 + 1 lb/A; 2-chloro-*N*-ethyl-*N*-phenylacetamide (CP6936) at 3, 5, and 7 lb/A; PGBE ester of 2,4-D at 1½ lb/A; simazin at 1, 2 and 4 lb/A; and 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine (G-27901) at 2, 4, and 8 lb/A. In addition 2,5-dichloro-3-nitrobenzoic acid (ACP M-460) and ACP M-503 (unpurified ACP M-460) were applied at 4, 6, and 8 lb/A at Columbus.

At emergence: alkanolamine salts of DNBP at 3 lb/A; simazin at 1 and 2 lb/A; and amitrol at ½ and 1 lb/A. 2-leaf stage: alkanolamine salts of DNBP at 3 lb/A, applied only at Hoytville; 2,3,6-TBA (Amchem) at 1, 2, and 3 lb/A; and amitrol at ½ and 1 lb/A. 4-leaf stage at Hoytville and Wooster, 4-6-leaf stage at Columbus: alkanolamine salts of DNBP at 3 lb/A; 2,3,6-TBA (DuPont) at 1, 2, and 3 lb/A; amitrol at ½, 1, and 2 lb/A; diuron at 2 pt/A; PGBE ester of 2,4-D and alkanolamine salts of 2,4-D at ¼ and ½ lb/A; and HCA (emulsifiable) at 2 and 4 lb/A.

At maturity the only corn that showed herbicide injury was that treated with amitrol at 1 and 2 lb/A at the 4-6-leaf stage at Columbus. The amitrol at 1 lb/A injured the corn slightly, at 2 lb/A, rather severely.

The following pre-emergence treatments reduced the weed population 90% or more at Hoytville, ,Columbus and Wooster, and were the most satisfactory; simazin at 2 and 4 lb/A, 2,3,6-TBA (Amchem and DuPont) at 4 lb/A, and G-27901 at 8 lb/A. Simazin at 1 lb/A, CDAA plus 2,4-D at 2 + 1 and 3 + 1, diuron at 2 pt/A, G-27901 at 6 lb/A and neburon at 6 lb/A gave excellent weed control at Columbus and Wooster, fair control at Hoytville. ACP M-460 at 4, 6, and 8 lb/A (applied only at Columbus) reduced the weed population 95% or more, ACP M-503 at 6 and 8 lb/A, 85 to 90%. 2,4-D at 1½ lb/A gave good control of the broadleaf weeds and fair control of millet at the three locations. The other pre-emergence treatments gave fair to poor weed control at two or more of the locations. At emergence: simazin at 2 lb/A reduced the weed population 90% or more at Hoytville, Columbus and Wooster, at 1 lb/A 90% or more at Columbus and Wooster, 65% at Hoytville: DNBP at 3 lb/A gave excellent weed control at Wooster, fair control at Columbus and poor control at Hoytville. Amitrol at 1 lb/A gave fair control of weeds at Wooster and Columbus, poor control at Hoytville. 2-leaf stage: 2,3,6-TBA at 3 lb/A gave excellent weed control at Columbus and Hoytville, at 1 and 2 lb/A, excellent control at Hoytville and fair control at Columbus. Amitrol at 1 lb/A gave fair control of weeds at Columbus, poor control at Hoytville. 4-leaf stage at Hoytville and Wooster, 4-6-leaf stage at Columbus: DNBP at 3 lb/A, diuron at 2 pt/A, 2,3,6-TBA at 2 and 3 lb/A and amitrol at 1 lb/A reduced the weed population 90% or more at Hoytville, Columbus and Wooster and were the most satisfactory. Amitrol at ½ lb/A gave good weed control. PGBE ester of 2,4-D at ¼ lb/A and alkanolamine salts of 2,4-D at ½ lb/A gave good to excellent control of broadleaf weeds, poor control of millet. The other treatments at the 4-leaf stage gave poor weed control. (The Ohio Agricultural Experiment Station.)

**Herbicides for control of weeds in field corn. Brown, D. A.** Pre-emergence applications were made by over-all spraying of Nodak blend hybrid corn several days before plants emerged. Continued dry weather for three weeks after spraying prevented weeds and corn from growing. When rain came the action of the herbicides was readily observed but results were by no means as positive as in 1957. Simazin at 3 and 6 lb/A gave weed control of 86 and 92 percent respectively without any injury to corn; 2,3,6-TBA at 2 and 4 lb/A, 84 and 96 percent control of weeds but rather severely injured the corn. EPTC at 4 and 8 lb/A gave 80 and 86 percent weed control with slight injury to corn. Compounds giving only mediocre weed control but with no injury to corn were alpha-chloro-*N*-ethyl-*N*-phenylcarbamate (CP6936) at 2 and 4 lb/A and 2-chloro-4-diethylamino-6-isopropylamino-*s*-triazine (G30031) at 4 and 8 lb/A. Simazin used in a large field of corn gave extremely encouraging results and proved for the second year in succession that it is a valuable herbicide for pre-emergence applications on corn. Post-emergence applications were made to corn plants at two stages: (1) 6 inches high, (2) 12 inches high. Excellent weed control was obtained at stage one with 2,4-DB ester 18 oz/A; 2,4-D ester at 6 oz/A; and fair to good control with MCPA ester at 6 oz/A and MCPB ester at 18 oz/A. The 2,4-D ester injured the corn slightly. The others gave no evidence of injury. A mixture of chlorinated benzoic and cresoxyacetic acids (F1815), at 6 oz/A gave very satisfactory weed kills but weakened the stems of corn. G30031 at 2 lb/A gave only fair weed control but left the corn normal. Injury to corn plants was most pronounced at the 12-inch height. At this later stage weeds were well advanced and control was no better than 60 percent of that obtained at the earlier stage. (Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Man.)

**Persistence of chemical weed control in corn in a high rainfall season. Egley, G. H., Morre, D. J., and Rogers, B. J.** Triplicated plots infested with *Digitaria sanguinalis, Panicum* spp., *Setaria* spp., *Echinochloa crus--galli, Datura stramonium, Amaranthus* spp., *Polygonum pennsylvanicum, Chenopodium album,* and *Ambrosia artemisiifolia* were treated with pre- and post-emergence (amitrol) chemicals. Application was made on May 29 to a Chalmers silt loam soil located on the Purdue Agronomy Farm, Lafayette, Indiana. In the next two months over 21 inches of rain fell; cultivation for weed control was almost impossible. At the end of this high rainfall period weed counts were made to determine the effectiveness of the various chemicals for limiting weed populations under these conditions. The following list includes the chemical (with special formulations in some cases) and rates/A, the rate which gave the best control, and the percent stand reduction (as compared with checks) of grasses and broadleaves: 2,4-D, propylene glycol ester (2 lb), 2 lb, 0, 30%; CDAA (2, 4 lb) 2



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lb, 50% 0; CDAA concentrate (2, 4 lb) 4 lb, 50%, 20%; simazin granular (1, 2 lb) 2 lb, 80%, 95%; simazin paste (1, 2 lb) 2 lb, 25% 80%; simazin 50% wettable powder (1, 2 lb) 2 lb, 30%, 75%; simazin 80% wettable powder (1, 2 lb) 2 lb, 50%, 75%, 2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine (Geigy 30027) (1, 2 lb) 2 lb, 30%, 95%; EPTC (3, 6 lb) 3 lb, 30%, 30%; amitrol (Post, 1, 2 lb) 1 lb, 0, 70%. The optimal rate as given depends on the overall weed control and the absence of observable crop injury. The triazines gave the best control; with these chemicals control of broadleaves was usually much better than control of grasses. (Department of Botany and Plant Pathology, Agriculaural Experiment Station, Purdue University.)

**A comparison of different forms of 2,4-D for weed control in corn. Fletchall, O. Hale and Talbert, Ronald T.** Different forms of 2,4-D, each at 1 and 2 lb/A, were sprayed on May 16, 1958 for pre-emergence weed control in corn. Averaging the two rates for each form, weeds per 100 sq ft 27 days after treatment were: check, 122; butyl ester of 2,4-D, 33; dimethylamine salt of 2,4-DB, 58; 2,4-D acid, 30; and 2,4-dichlorophenoxyacetamide, 31. (Contribution of the Missouri Agricultural Experiment Station.)

**2,4-D at various rates and at different intervals after corn emergence for weed control*. Freeman, J. F.** Corn (Ky 105 Hybrid) was planted June 15, 1957 on Maury silt loam soil which was heavily infested with redroot pigweed. Corn came up a good stand and pigweed a dense stand with some undergrowth of crabgrass starting later. Treatments were 2,4-D as the amine salt applied at rates of 4, 8, 12, and 16 oz/A at each of 3 dates, the first, 7 days after corn emergence with plants 4" tall and pigweed ½" tall; the second date, 13 days after emergence with corn 9-12" tall and pigweed 1½" tall; the third date, 30 days after emergence with corn 24-30" tall and pigweed 12-18" tall, cultivated and uncultivated checks. Each rate of 2,4-D was used in 32 gal/A water, sprayed over corn and weeds at each date. The number of weeds in each of 6 one sq ft quadrats/plot was determined July 15 for plots of the first and second treatment dates and for the checks, and August 5 for those of the third treatment date. Weeds were removed from sprayed plots shortly after obtaining weed data—by cultivation and hand hoeing on plots of first and second treatment dates and by scraping with hoe on plots of third date treatments. Treatments at 7 or 13 days after emergence were about equally effective in controlling early weeds—the average number for the 4 rates being 7 weeds/sq ft for each date as compared to 59/sq ft (49 broadleafs + 10 grasses) on the uncultivated check, and were much better than treatments 30 days after emergence which averaged 17 weeds/sq ft. In the two early treatment dates the 8 oz/A rate of 2,4-D gave about as effective weed control as the 12 or 16 oz rates, and was slightly more effective than even the 16 oz rate of the late treatment date. Yields of ear corn for none of the rates of 2,4-D at the first or second dates were reduced significantly below that of the cultivated check (88 bu/A) while those of all rates of the late treatment (av yield 34 by/A) were greatly reduced, probably because of the serious competitive effects of the weeds on the corn prior to the late treatment. (Agronomy Department, Kentucky Agricultural Experiment Station.)

**Pre-emergence control of weeds in corn with herbicides. Freeman, J. F.** Corn (Ky 105 hybrid) was planted in Captina silt loam soil June 3, 1958. A mixture of German millet and redroot pigweed was seeded in 4" drills over the corn rows with a clover seed drill to provide a uniformly high weed population. Herbicide-spray treatments were applied in 13⅓" bands centered over the corn rows June 5 at rate equivalent to about 39 gal/A solid coverage. Treatment rates (solid coverage basis) were: simazin, 1, 1.5, and 2 lb/A; 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine (G-27901), 1.5, 2.5, and 4 lb/A; EPTC, 2, 3 and 4 lb/A; tris-(2,4-dichlorophenoxyethyl) phosphite (3Y9), 2, 3, 4 lb/A; CDAA, 3 and 4 lb/A; and at like rates + 0.5 lb 2,4-D as PGBE ester; CDAA-S(solventless) 3 and 4 lb/A; cultivated and uncultivated checks. Hot, dry weather prevailed until June 9 when good rains occurred. None of the herbicidal treatments affected stand or early growth of the corn. The millet, simulating grass weeds, and pigweed emerged where treatments did not inhibit and grew rapidly in the continuing moist weather. The number of grass and broadleaf weeds was determined in the row-band in each of eight 8" X 24" quadrats per plot July 1. Based on the number of weeds present on the uncultivated check treatment—48.6/sq ft (29.6 grasses + 19 broadleafs) simazin at 1, 1.5, and 2 lb/A resulted in 92%, 98% and 100% control respectively; G-27901 at 1.5, 2.5, and 4 lb/A in 67%, 94%, and 99% control; EPTC at 2, 3, and 4 lb/A in 77%, 95% and 93% control; 3Y9 at 2, 3 and 4 lb/A in 67%, 90% and 91% control; cultivated twice, 94% control; CDAA in either formulation or combinations with 2,4-D gave less than 50% control of weeds. Corn yields were not taken due to continuous wet weather during the month following weed population counts which prevented intended cultivation of all treatments and permitted the weeds to take over. (Agronomy Department, Kentucky Agricultural Experiment Station.)

**Pre-planting and pre-emergence herbicide trials for wild cane control in corn. Shafer, N. E.** "Wild cane" is *Sorghum vulgare*, variety apparently Black Amber, which maintains itself in corn by shattering after early maturity. Also called "shatter cane." EPTC was applied at rates of 3 and 6 lb/A both as a spray and as granules (5%) at three separate locations. One acre blocks of each rate of each formulation were applied by airplane on May 9 at two of the locations. These were disked in the following day and planted 3 or 4 days later. Corn at the third location had already been surface planted at time of chemical treatment on May 12. Approximately ½" of rain fell just as the plot spraying was completed so no soil incorporation was used. Data taken June 19 indicated that practical control was obtained at only one location. Results were poor where rain followed chemical treatment. Of the two locations where the chemical had been disked in, very little control was apparent where disking and listing were the cultural practices used. Chemical treatments were successful only where the land had been plowed, sprayed, disked and then surface planted. Granules were more effective than the spray treatments. Some corn injury was apparent on all treatments except where rain followed application. Up to 30% of the corn showed stunting and rolled leaves where disking and listing had been used. Where the corn was surface planted 10 to 20% corn injury occurred with greatest injury from the highest rate of chemical. (Contribution of Agronomy Department, University of Nebraska.)

**Carryover of herbicides in processed sweet corn. Strachan, G. and Torfason, W. E.** Replicate samples of the kernels were removed from the usable cobs from two sweet corn plots 25 ft long by four rows wide. One plot had been treated with 2 lb/A of sizamin while the other plot received no treatment. These samples were processed by canning, using the accepted method, with the exception that distilled water rather than tap water was used and no salt was added. After two months storage, the samples were submitted to a six member taste panel. Panel members were unable to detect any abnormal flavor or odor, or a difference between the treated and untreated plots. However, several workers that tasted the raw corn thought there was an off-flavor in the material from the treated plot. When suitable techniques are available a chemical analysis will be made. (Canada Department of Agriculture, Experiment Farm, Lethbridge, Alberta.)

**Pre- and post-emergence applications of simazin at Halstad, Minnesota to control weeds in corn. Zinter, C. C., Amstrup, C. R. and Slough, A. T.** Pre-emergence applications of 4, 2 and 1 lb/A in 10 gal/A water applied in triplicate May 27, 1958; crops were seeded May 26. Post-emergence applications at same rates June 9,



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1958. Final observations July 22 indicated 4 lb/A pre-emergence controlled all weeds (setaria, wild oats, mustard, pigweed, lambsquarters). 2 lb/A pre-emergence killed 98% of setaria, 75% of wild oats, and all broadleaved weeds. 2 lb/A post-emergence killed 75% of setaria and 75% broadleaved weeds. 4 lb/A post-emergence killed 100% of broadleaved weeds and 90% of setaria. 3 lb/A post-emergence killed 100% of broadleaved weeds and 75% of setaria. 1 lb/A post-emergence killed 50% of setaria and set back, but didn't reduce, population of broadleaved weeds. In all cases,, corn was excellent. (Contribution of F. H. Peavey & Co., Minneapolis, Minn.)

## FLAX

**Herbicides for control of wild buckwheat in flax. Brown, D. A.** Flax was seeded on fallow land infested with wild buckwheat but relatively free of other weeds. Half the plots received a second application eight days after the first. Weather remained very dry throughout the growing season with the exception of light rains late in June and up to July 10. Results are tabulated below.

| Treatment | Rate oz/A | Control wild buckwheat, pct. Treated | | Yield, bu/A flaxseed Treated | |
|---|---|---|---|---|---|
| | | Once | Twice | Once | Twice |
| 2,4-D (butyl ester) | 4 | 26 | 42 | 26.6 | 23.9 |
| | 6 | 38 | 56 | 26.7 | 24.8 |
| | 8 | 43 | 75 | 25.9 | 23.3 |
| 2,4-D(isopropyl-amine salt) | 4 | 15 | 36 | 24.9 | 25.4 |
| | 6 | 24 | 52 | 25.4 | 27.4 |
| | 8 | 35 | 60 | 26.8 | 25.7 |
| Neburon | 8 | 22 | 26 | 24.1 | 25.9 |
| | 16 | 35 | 43 | 24.7 | 25.0 |
| | 24 | 38 | 68 | 23.9 | 25.5 |
| Weedy check | | 0 | 0 | 24.3 | |
| Hand-weeded check | | 100 | 100 | 27.1 | |
| Average | | | | 25.4 | 24.1 |

(Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba.)

**Spray volume effect on 2,4-D applied for the control of Russian thistle in flax. Sexsmith, J. J.** Redwood flax was seeded on a silty clay loam dry-land soil on May 9, 1958. On June 13 the butyl ester of 2,4-D at rates of 0, 4, 6, and 8 oz/A was applied in water at volumes of 6.3, 11.7, 19.2, and 45.5 gpa, in a six-replicate split-plot test. When treatments were made, the relatively poor stand of flax was variable from 2½ to 5½ inches tall with up to 30 expanded leaves, and the light to medium infestation of Russian thistle was from the late "pine-leaf" stage to 4 inches tall with 4 to 6 well-formed branches. Mature height measurements of flax were taken, and visual control estimates of Russian thistle were made on August 31. Yield samples were taken on September 3. At the lowest volume almost equal control of Russian thistle resulted from the 4-, 6-, and 8-oz rates, while at the highest volume the 8-oz rate was more than twice as effective as the 4-oz rate. Further, weed control from the 8-oz rate at 45.5 gpa was less than from the 4-oz rate at 6.3 gpa. The different volume applications had no differential effect on mature height of the flax crop, but on the basis of all volumes there was a decrease in height with increasing rate of 2,4-D, the height of flax on the 6- and 8-oz plots being significantly less than that of the untreated checks. Yield results were not considered too reliable because of the unevenness of the original stand, aggravated by cutworm attack. However, based on all 2,4-D rates, there was a trend toward increased yield with increased volume up to and including 19.2 gpa. This would indicate a possible decrease in 2,4-D injury up to the point where the greater weed competition of the 45.5 gpa volume became the major cause of yield decrease. All 2,4-D treatments allowed for the production of higher yields than were possible in the corresponding untreated checks at each of the four volumes. (Canada Department of Agriculture, Experimental Farm, Lethbridge, Alberta.)

**Influence of volume of water with herbicides on flax. Brown, D. A.** Water volumes of 5, 10, and 15 gal/A were compared when applied with 4 and 8 oz/A of butyl esters of 2,4-D and MCP. Treatments were made at two stages of development in flax plants, (1) plants 3 inches high, (2) plants 6 inches high. Flax was seeded on weed free fallow. The crop was subjected to drouth throughout the season but plants were at all times in perfectly healthy condition. Results in bu/A; 5 gal/A, 26.6; 10 gal/A, 25.8; 15 gal/A, 25.9; hand weeded 27.2: and weedy check 27.8. Treating at the early stage gave a yield of 26.3 bu/A compared with 25.9 from the later treated stage. Influence of rate and kind of chemical on yield was: 2,4-D ester 4 oz/A, 24.9 bu; 8 oz/A, 22.8 bu; MCPA ester 4 oz/A, 27.6 bu; and 8 oz/A, 27.7 bu/A. Under conditions prevailing in 1958, volume of water between 5 and 155 gal/A made no difference in yield. Neither did height of plant between 3 and 6 inches. The MCPA ester gave yields equal with the hand weeded check. These were significantly higher than yields from the 2,4-D ester. (Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba.)

**Chemical control of green foxtail in flax. Brown, D. A.** Flax plots were extremely heavily infested with green foxtail. Chemicals used were TCA at 3.5 and 8 lb/A, dalapon and 2,3,6-TBA at 0.75, 1.5 and 2 lb/A. Spraying was done at two stages of growth: (1) flax 4 inches high, foxtail early seedling; (2) flax 7 inches and foxtail past seedling stage. At the early stage TCA gave kills of foxtail of 84, 92 and 90 percent respectively for the three rates of application. Dalapon gave kills of 82, 90 and 94 percent and 2, 3, 6-TBA 25, 40 and 49 percent. Grass plants became progressively more tolerant to the chemicals as they aged. At the second growth stage percentage kills at the respective rates were: TCA 66, 74 and 85; dalapon 54, 79 and 74; 2,3,6-TBA, 19, 23 and 36. The performance of TCA and dalapon differed little at the earlier growth stage but at the advanced stage but at the advanced stage TCA was more efficient. The 2,3,6-TBA was inadequate for control of green foxtail and even at the lowest rate killed the flax plants. Neither TCA nor dalapon at any rate injured flax plants, and they enhanced yields by 60 to over 100 percent, especially when applied at the early growth stage. (Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba.)

## SOYBEANS

**Herbicides on soybeans. Bondarenko, D. D. and Dowler, Clyde.** Blackhawk soybeans were planted in Hoytville silty clay loam on May 20, 1958 at the Northwest Substation, Hoytville, and in Canfield silt loam on May 29 at Wooster. Hawkeye soybeans were planted in a Miami-Brookston silty clay loam on May 26 at Columbus. The soybeans were planted in 42-inch rows. German millet was sown in all plots to simulate annual grasses. At Hoytville and Wooster the plots had a natural infestation of smartweed and common ragweed, at Columbus, redroot pigweed and lambsquarters. Triplicate 4-row plots, 35 feet long, were band-treated (21-inch bands) over the soybean rows with each rate of



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each herbicide. All rates are given as over-all rates; the amount actually applied was one-half these rates. All herbicides were applied in 40 gpa water. Pre-emergence: alkanolamine salts of DNBP, CIPC, 2,5-dichloro-3-nitrobenzoic acid (ACP M-460, applied only at Columbus) and ACP M-503 (unpurified ACP M-460, only at Columbus) at 4, 6 and 8 lb/A; CDAA, sodium salt of NPA, EPTC, and 2-chloro-*N*-ethyl-*N*-phenylacetamide (CP6936) at 2,4 and 6 lb/A; sodium salt of NPA plus CIPC at 2 + 2 and 3 + 3 lb/A; and PGBE ester of 2,4-D (only at Columbus) at 1½ lb/A. The following herbicides were applied at the cotyledon stage, the 2-true-leaf stage and at the 2 to 5-leaf stage: alkanolamine salts of DNBP at 1½, 2¼ and 3 lb/A; and alkanolamine salts of 2,4-D at ⅛ and ¼ lb/A. At maturity the only soybeans that showed herbicide injury, which was slight, were those treated pre-emergence with ACP M-503 at 6 and 8 lb/A at Columbus.

The mixture of NPA plus CIPC at 3 + 3 lb/A reduced the stand of the millet and the broadleaf species 90% or more at Hoytville, Columbus and Wooster, and was the most satisfactory pre-emergence treatment. This mixture at 2 + 2 lb/A gave fair control of the weeds. ACP M-460 and ACP M-503 at 6 and 8 lb/A reduced the stand of millet, pigweed, and lambsquarters 90% or more. CIPC at 8 lb/A at the three locations gave excellent control of all weeds except ragweed. DNBP at 6 and 8 lb/A, NPA at 4 and 6 lb/A and 2,4-D at 1½ lb/A gave fair control of all the weeds. The other pre-emergence treatments gave fair to poor weed control. DNBP applied post-emergence at 2¼ and 3 lb/A at the 2-5-leaf stage (first trifoliate expanded about one-half maximum size) reduced the stand of all species of weeds 90% or more. The leaves of the soybean plants were burned but recovery was rapid. 2,4-D amine at ¼ lb/A applied when the soybeans were at the 2 to 5-leaf stage gave good control of ragweed, pigweed, and lambsquarters and did not injure the soybeans.

Harosoy soybeans were planted in a Miami-Brookston soil in 42-inch rows on June 24, 1958 at Columbus. All the plots had a natural infestation of pigweed, lambsquarters, and crabgrass. Triplicate 4-row plots, 200 feet long, were treated over-all pre-emergence with the sodium salt of NPA plus CIPC at 2 + 4 lb/A in 40 gpa water on June 24. 3-amino-2,5-dichlorobenzoic acid (ACP M-629) at 1 and 4 lb/A was applied pre-emergence to non-replicated plots on June 25. DNBP as the alkanolamine salts at 2¼ lb/A was applied to triplicate plots at the 2 to 5-leaf stage on July 14. On October 6 the plots treated with NPA plus CIPC at 2 + 4 lb/A showed 90% reduction in stand of all weeds. Germination of soybeans was slowed somewhat by the NPA plus CIPC, but only slight injury was apparent on October 6. The plot treated with ACP M-629 at 4 lb/A was weed-free all season, and the soybeans were not injured. ACP M-629 at 1 lb/A reduced the stand of pigweed and lambsquarters 85%, crabgrass, 100%. The DNBP at 2¼ lb/A applied at the 2 to 5-leaf stage reduced the weed population about 90% and injured the soybeans slightly. (The Ohio Agricultural Experiment Station.)

**Simazin on soybeans, navy beans, pinto beans and sugar beets. Bondarenko, D. D.** Duplicate plots, 20 by 30 feet, that had been fall plowed, were treated with simazin at 4, 8, and 12 lb/A on May 22, 1957 and on May 28 (one application per plot). The plots were dragged and then planted to Hawkeye soybeans on June 8. The soybeans germinated normally but died at the bileaf (2-true-leaf) stage. The plots were dragged and then planted to a second crop of soybeans (var. Harosoy) on June 27. On July 8 one row of navy beans, pinto beans and sugar beets was planted across each plot between rows of the soybeans. On September 15, 1957 the navy beans, pinto beans and sugar beets in all the treated plots and the soybeans in the plots treated with simazin at 8 and 12 lb/A showed a 95 to 100 percent reduction in stand. The soybeans treated with the 4-pound rate showed a 50 percent reduction in stand and were slightly less vigorous than the checks.

In another experiment triplicate square rod plots were treated with simazin at 2, 4, 8, and 12 lb/A on October 1, 1957. The plots were disked once on October 15. On May 22, 1958 the plots were dragged and planted to Hawkeye soybeans. On June 10 one row of navy beans and sugar beets was planted between rows of soybeans across a check plot and two other plots treated with simazin at 2 and 4 lb/A. On August 15 the soybeans treated with simazin at 8 and 12 lb/A showed a 95 to 100 percent reduction in stand, at 4 lb/A, 40 percent. The soybeans treated at the 2-pound rate were not damaged. The navy beans in the plot treated with simazin at 4 lb/A were damaged slightly; at 2 lb/A no damage occurred. The sugar beets in the plot treated with simazin at 4 lb/A were killed. The beets in the plot treated at 2 lb/A showed a 60 percent reduction in stand and were somewhat less vigorous than the beets in the check plot. (The Ohio Agricultural Experiment Station.)

**Herbicides for control of weeds in soybeans. Brown, D. A. Pre-emergence.** CP 6936 (alpha-chloro-*N*-ethyl-*N*-phenylacetamide), Chlorazine (2-chloro-4,6-bis(diethylamino)-*s*-triazine) and DCU were applied at 4 and 8 lb/A; DNBP at 3 and 7 lb/A; CIPC at 5 and 10 lb/A; and NPA at 3 and 6 lb/A. Applications were made in water at 25 gal/A approximately one week before bean plants emerged. Due to dry weather neither beans nor weeds made normal growth for several weeks after treatment. Weeds prevalent were green foxtail, redroot pigweed, lambsquarters, wild buckwheat, Russian thistle, stinkweed, perennial sowthistle and hoary cress. Weed control was disappointing mainly perhaps because of the conditions occasioned by severe drouth. Percentage weed control ratings and effect on beans were: Chlorazine 58%, slight injury; CP6936 26%, no injury to beans; NPA 25%, no injury; CIPC 18%, no injury; DNBP 15%, no injury to beans. The crop did not mature before frost. **Post-emergence.** Treatments were DNBP at 2, 3, and 6 lb/A. Applications were made at the one true-leaf and three true-leaf stages. DNBP gave excellent control of annual broad-leaved weeds but not of the perennials, sowthistle and hoary cress. This herbicide caused injury to bean plants, especially at the two to three true-leaf stage, but recovery was 80 to 100 percent. After three years of testing satisfactory control of weeds in soybeans by herbicides has not been achieved. (Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba.)

**Effect of 2,4-D and 4-(2,4-DB) used post-emergence on soybeans at various rates at two stages of growth. Freeman, J. F.** Soybeans (Clark variety) were planted June 14, 1957. Good stands resulted and few weeds were present. Row cultivations were given as needed to prevent growth of weeds. Treatments were 2,4-D and 4-(2,4-DB) as amine salts at 1, 2, 4, and 8 oz/A in water spray, 32 gal/A, broadcast over soybeans July 2 when plants were 6" high and the 2d trifoliate leaf just expanded; same materials and rates July 9 when plants were 8"-10" high and 4th trifoliate leaf just expanded; and untreated check. Yields of beans treated with herbicides were not reduced significantly from those of untreated checks (yield 35 bu/A) except for 2,4-D at 8 oz/A at 2d trifoliate leaf stage (yield 21 bu/A) and for 4-(2,4-DB) at the same rate and growth stage (yield 27 bu/A). These yield reductions were attended by severe reductions in height of plants and by increased lodging. Lodging was severe for 2,4-D at 4 and 8 oz rates for both treatment dates and for 4-(2,4-DB) at the same rates for the earlier date only. Under field harvest conditions severe lodging would have resulted in much lower yields than were obtained by hand-harvesting methods. Neither of these herbicides used at rates of 1 or 2 oz/A at either of these early growth stages resulted in serious harm to the soybeans. (Agronomy Department, Kentucky Agricultural Experiment Station.)

**Early post-emergence treatment of soybeans with various rates of DNBP at different stages of growth. Freeman, J. F.** Soybeans (Clark variety) were planted

in 36" rows on Burgin silt loam soil June 14, 1957. A mixture of German millet 10 lb and red root pigweed 2 lb/A was drilled solid over the soybean rows with a clover seed drill. Emergence of soybeans began June 18 and of weeds shortly afterward due to favorable moisture conditions. Treatments: DNBP as the amine salt 0.75, 1.50, 2.25, and 3 lb/A at each of three growth stages: (1) Cotyledon leaf, June 20; (2) unifoliate leaf, June 25; (3) 2d trifoliate leaf, July 1; cultivated (early) check; uncultivated (early) check. DNBP was applied in 32 gal/A water, solid coverage. Treatments were in a randomized block design with 4 replications. Maximum soil temperatures 1" deep at treatment stages 1, 2, and 3 were 95°, 86° and 95° F. respectively. The number of weeds for each treatment was determined July 12. Plots of all treatments were then cultivated and hand chopped to rid of weeds. Stand, height, and yield data were obtained at time of harvest. Weed controls: Based on the uncultivated check which had 30 weeds/sq ft (20 grass + 10 broadleaf) DNBP at 2.25 and 3 lb rate, at stage 1 resulted in 75% and 82% control of weeds, and at stage 2 in 75% and 88% control. The lighter rates at stages 1 and 2 and all rates at stage 3 resulted in partial but inadequate weed control. Effect on soybeans: At stage 1, stand, height, or yield of beans was not reduced by use of DNBP even at 3 lb/A rate compared to cultivated check (yield 38 bu/A). At stage 2, the 3 lb/A rate reduced stand two-thirds, height of plants 30% and yield 30% whereas the 2.25 lb/A rate reduced stand more than 40%, but the yield reduction was not significant. At stage 3, DNBP apparently caused no permanent harm to the crop but the poor weed control at all rates resulted in yield of beans similar to that of the early uncultivated check which was cultivated at same time as were the sprayed plots. (Agronomy Department, Kentucky Agricultural Experiment Station).

**Persistence of chemical weed control in soybeans in a high rainfall season. Morre, D. J., Egley, G. H., and Rogers, B. J.** Triplicated plots infested with *Digitaria sanguinalis, Panicum* spp., *Setaria* spp., *Echinochloa crus-galli, Datura stramonium, Amaranthus* spp., and *Chenopodium album* were treated with pre- and post-emergence chemicals. Application was made on May 28 to a Chalmers silt loam soil located on the Purdue Agronomy Farm, Lafayette, Indiana. In the next two months over 21 inches of rain fell; cultivation for weed control was almost impossible. At the end of this high rainfall period weed counts were made to determine the effectiveness of the various chemicals for limiting weed populations under these conditions. The following list includes the chemicals (all pre-emergence except those designated "post") and rates/A used, the rate which gave the best control, and the percent stand reduction (as compared with checks) of grasses and broadleaves: NPA, sodium salt (3, 6 lb) 6 lb, 25%, 5%; DNBP (6, 7½, 9) 9 lb, 30%, 95%; DNBP-post (¾, 1½, 3 lb) 1½ lb, 30%, 50%; PCP, sodium salt (15, 20, 25 lb) 25 lb, 75%, 80%; CDAA concentrate (2, 4 lb) 2 lb, 70% 0,; and 2,5-dichloro-3-nitrobenzoic acid, sodium salt (dinoben) (4, 8 lb) 8 lb, 75%, 60%. The post-emergence DNBP treatments were made just as the cotyledons emerged. The optimal rate as given depends on the overall weed control and the absence of observable crop injury. (Department of Botany and Plant Pathology, Agricultural Experiment Station, Purdue University).

## FIELD AND CANNING PEAS

**Herbicides for weed control in field peas. Brown, D. A.** Pre-emergence treatments were Chlorazin (2-chloro-4,6-bis(diethylamino)-*s*-triazine), EPTC and CP-6936 (alpha-chloro-*N*-ethyl-*N*-phenylacetamide) all at 4 and 8 lb/A applied four days before peas emerged. Weeds prevalent included green foxtail, lambsquarters, redroot pigweed, stinkweed, wild buckwheat and wild oats. Extremely dry weather prevented weed growth and following early July rains, when weeds did grow, results were disappointing. In overall weed control Chlorazin, CP6936 and EPTC rated equally. None of the chemicals reduced the yield of Arthur peas. Post-emergence treatments were made when pea vines averaged 6 inches in length. All chemicals were applied in 30 gal/A of water. Prevalent weeds were the same as above. TCA at 3 lb/A and dalapon at 1.5 lb/A, both plus 3 oz /A MCPA amine, were superior.

| Treatment | Rate per acre | Overall weed control, % | Yield peas bu/A |
|---|---|---|---|
| MCPA amine | 4 oz | 64 | 50.5 |
| MCPA amine | 6 oz | 76 | 43.4 |
| 2,4-D amine | 4 oz | 70 | 44.6 |
| 2,4-D amine | 6 oz | 84 | 39.1 |
| MCPB amine | 8 oz | 65 | 46.0 |
| MCPB amine | 16 oz | 90 | 43.0 |
| DNBP amine | 12 oz | 80 | 42.6 |
| DNBP amine | 24 oz | 95 | 25.5 |
| TCA | 3 lb | 30* | 41.8 |
| TCA | 6 lb | 45* | 33.9 |
| dalapon | 1.5 lb | 28* | 34.4 |
| dalapon | 3 lb | 50* | 15.1 |
| TCA + MCPA amine | 3 lb + 3 oz | 94 | 41.5 |
| dalapon + MCPA amine | 1.5 lb + 3 oz | 96 | 32.4 |
| Weedy checks | | | 38.9 |

* Grass only.

(Contribution from Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba).

**Pre-emergence weed control in processing peas, 1958. Nelson, D. C., Nylund, R. E., and Dinkel, D. H.** Processing peas seeded at four locations in Minnesota, (Fairmont on May 6, Ostrander on May 10, Stewart on May 14, and Waseca on May 15) were sprayed with the following twenty herbicides (rates per acre): 2 lb monuron, 6 lb DNBP amine, 4 lb CDAA, 2 and 4 lb 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine (G-27901), 2 lb dalapon, 2 and 4 lb 2-chloro-4-diethylamino-6-isopropylamino-*s*-triazine (G-30031), 6 lb TCA sodium salt, 5 and 10 lb EPTC, 2, 4, and 6 lb 2-chloro-*N*-ethyl-*N*-phenylacetamide (CP 6936), 2 lb CDAA plus 3 lb DNBP amine, 2 lb G-27901 plus 4 lb CP 6936, and 4, 6, and 8 lb 2,5-dichloro-3-nitrobenzoic acid, Na salt (ACP-503). Each of these treatments was applied at 30 psi pressure in 40 gal water per acre to duplicated one-half square rod plots. Every third plot was an unsprayed control plot so that each sprayed plot was adjacent to a control plot. Sprays were applied the same day as seeding at Stewart, one day after seeding at Fairmont and four days after seeding at Waseca and Ostrander. Peas had not started to germinate at Stewart and Fairmont, but had a ¼" sprout at Waseca and Ostrander at spraying. Herbicides were applied at all locations to very dry soils free from germinated weeds. In the twelve days following spraying, rainfall totaled .61" at Waseca, .65" at Stewart, .54" at Ostrander and .71" at Fairmont. Temperatures averaged 60° F. at Waseca and Stewart, 61° F. at Ostrander and 64° F. at Fairmont. Weed control and pea injury ratings were recorded May 28 at Fairmont and Ostrander, on June 5 at Stewart and on June 11 at Waseca. The weeds present at all locations were principally annual grasses, (*Setaria* spp. and *Echinochloa crusgalli*) with a scattering of broad-leaved weeds. Only 4 lb CDAA and 6 lb CP 6936 gave good to excellent control of annual grasses at all locations. There was no interaction between locations and herbicides. At Waseca plots were underseeded with alfalfa. 2 and 4 lb G-30031 caused moderate injury, and 4, 6 and 8 lb ACP-503 caused severe injury to the underseeding; other treatments caused little or no injury. Broad-leaf weeds were not present at any location in sufficient numbers for



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accurate ratings. Peas treated with 2 lb dalapon, 6 lb TCA, 5 and 10 lb EPTC and 4, 6 and 8 lb ACP-503 showed slight to moderate injury three weeks after application at Waseca, however, only peas treated with 2 lb dalapon, 6 lb TCA and 6 and 8 lb ACP-503 showed injury one to three weeks later. The latter herbicides also caused slight to moderate injury to peas at Ostrander and Stewart. Analysis of yields of shelled peas and tenderometer readings from Waseca and Ostrander showed no difference between the twenty treatments. (Paper No. 4005 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station).

**Post-emergence weed control in processing peas, 1958. Nelson, D. C., Nylund, R. E., and Dinkel, D. H.** Processing peas, (var. Dark-skinned Perfection at Fairmont, Minnesota, var. Early Perfection at Ostrander; and late canning var. #250 at Stewart); were sprayed at the 5 to 6 node stage with the following twenty herbicides: 1, 2 and 3 lb DNBP amine, 1 lb DNBP amine plus 1 lb dalapon, 6 oz MCP amine, ½ and 1 lb 2,4-DB amine, 5 lb EPTC, 4 oz 2,4-D lithium salt, 2 and 4 lb 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine (G-27901), 2 and 4 lb 2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine (G-30031), 6 oz MCP amine plus 1 lb dalapon, ½ lb 4-(2,4DB) amine plus 1 lb dalapon, 4, 6, and 8 oz MCP potassium salt, 1 lb amitrol, and 6 oz MCP potassium salt plus 1 lb dalapon. Each of these treatments was applied at 30 psi pressure in 40 gal water per acre to duplicated one-half square rod plots. Every third plot was an unsprayed control plot so that each sprayed plot was adjacent to a control plot. The weeds present at all locations were principally annual grasses, *(Setaria* spp. and *Echinochloa crusgalli)* at the 3 leaf stage at Stewart and Fairmont and the 2 leaf stage at Ostrander. On the day of spraying, the soil surface was dry at Ostrander and Fairmont and wet at Stewart (2.00" rain on the day prior to spraying). Temperatures were 65° F. at Stewart and Ostrander and 70° F. at Fairmont. In the twelve days following spraying, rainfall totaled 4.66" at Ostrander (3.83" on the 7th day after spraying), 1.93" at Fairmont (1.40" on the 5th day after spraying), and .51" at Stewart. Temperatures averaged 64° F. at Ostrander, 65° F. at Fairmont, and 57° F. at Stewart. Grass control and pea injury ratings were recorded 18, 20 and 28 days after spraying at Stewart, Fairmont and Ostrander, respectively. The following herbicides gave fair to good grass control at all locations: 4 lb G-27901, 4 lb G-30031 and all combinations containing 1 lb dalapon. There was a significant location x herbicide interaction: 1, 2, and 3 lb DNBP amine and 1 lb amitrol gave fair to excellent grass control at Stewart but little or no control at Fairmont. Similarly, 5 lb EPTC gave poor control at Stewart but fair control at Ostrander and Fairmont. Broadleaved weeds were not present at any location in sufficient numbers for accurate ratings. At Stewart 2 and 4 lb G-30031 and 1 lb amitrol killed the peas, and 4 oz 2,4-D lithium salt, 4 lb G-27901, 6 oz MCP amine and 8 oz MCP potassium salt, seriously injured peas. At Ostrander and Fairmont only 2 and 4 lb G-30031 seriously injured peas. At one location, Ostrander, yields of shell peas and tenderometer readings were recorded. Two and 4 lb G-30031 reduced yields 50 and 80%, respectively, compared with unsprayed checks. Tenderometer readings averaged 88 from plots receiving 2 lb G-30031, 86 from plots receiving 4 lb G-30031, and 108 from untreated checks. None of the other herbicides significantly affected yields or tenderometer readings at this location. Only treatments containing 1 lb dalapon gave fair to excellent grass control at all locations with only slight or moderate injury to peas. (Paper No. 4013 Scientific Journal Series of the Minnesota Agricultural Experiment Station.)

**Herbicides on eight varieties of processing peas. Sexsmith, J. J.** On May 14, 1958, the following eight vavieties of peas were seeded on a silty clay loam irrigated soil: Lincoln, Climax, Rocket, Pacemaker, Surprise, Early Perfection, Late Perfection, and Dark Skin Perfection. On June 16, when the peas were up to 8 inches tall and in the 4- or 5-joint stage, the following treatments were applied in 19.2 gal/A of solution: the sodium and diethanolamine salts of MCPA at 6 and 8 oz/A; and the sodium salts and butyl esters of 4-(MCPB) and 4-(2,4-DB), each at 16 and 24 oz/A. Crop injury ratings were taken on June 30. Herbicide injury to the crop was partly masked by the injury resulting from hail and high winds of June 27. No yields were taken. Because of hail and wind injury, the recorded effects of individual chemical rates on single varieties were not considered too reliable. However, based on results for all pea varieties, least injury was caused by the sodium salt of 4-(MCPB) at 16 oz, closely followed by the sodium salt of MCPA at 6 oz. and of 4-(2,4-DB) at 16 oz. Most severe injury resulted from the ester of 4-(2,4-DB), the injury from the 16-oz treatment being rated at over six times as severe as the injury from the 16-oz treatment of the sodium salt of 4-(MCPB). On the basis of injury from all chemicals, Climax was the most tolerant variety; Lincoln, Rocket, and Pacemaker were only slightly less tolerant; Early Perfection and Dark Skin Perfection were moderately susceptible to herbicide injury; and Late Perfection and Surprise were the most susceptible of the varieties included. (Canada Department of Agriculture, Experimental Farm, Lethbridge, Alberta.)

**Phenoxyacetic and phenoxybutyric herbicides for weed control in processing peas. Sexsmith, J. J.** On May 6, 1958, Dark Skin Perfection processing peas were planted on a silty clay loam irrigated soil. The following treatments were applied to quadruplicate 8- by 20-ft plots on June 5 in 19.2 gpa of solution: the sodium and diethanolamine salts of MCPA at 0, 4, 6, and 8 oz/A; the sodium salts and butyl esters of 4-(MCPB) and 4-(2,4-DB) at 0, 16, 20, and 24 oz/A. At time of treatment the peas were in the 2- to 4-joint stage ranging from 3 to 7 inches tall, and plants of the medium heavy stand of lambsquarters and redroot pigweed were from late seedling up to 2 in tall. Estimates of weed control and crop injury were made one month after treatment, and the plots were harvested on July 24 to obtain shelled green pea yields. Adaquate control of lambsquarters was obtained with the medium rate of all herbicides included in the test, and very poor control of redroot pigweed was obtained with all but the butyl ester of 4-(2,4-DB). Visible injury to the pea crop was very slight as a result of treatment with the two types of MCPA and the sodium salt of 4-(MCPB). The ester of 4-(MCPB) and the sodium salt of 4-(2,4-DB) caused noticeable crop injury, and rather severe injury resulted from treatment with the ester of 4-(2,4-DB). Shelled pea yields equal to or better than untreated check yields were obtained from all treatments except the ester of 4-(2,4-DB). The tenderometer readings showed a trend toward delayed maturity re sulting from most treatments but the differences were not significant. Treatments giving adequate control of lambsquarters consistent with good shelled pea yields were the 6-oz rates of the sodium and amine salts of MCPA and the 20-oz rate of the sodium salt of 4-(MCPB). Giving slightly more visible crop injury without significant effect on yield were the 20-oz rates of the ester of 4-(MCPB) and the sodium salt of 4-(2,4-DB). (Canada Department of Agriculture, Experimental Farm, Lethbridge, Alberta.)

## FORAGE LEGUMES

**2,4-D, 4-(2,4-DB) and DNBP on established alfalfa. Bondarenko, D. D.** Triplicate plots, 5 by 20 feet, of established alfalfa-ryegrass (about a 95-5 mixture) were treated at different stages of growth with alkanolamine salts of 2,4-D at ¼, ½ and 1 lb/A, dimethylamine salts of 4-(2,4-DB) at ½, 1 and 2 lb/A and alkanolamine salts of DNBP at 2 and 3 lb/A in 40 gpa water in the spring of 1958. The height of the alfalfa on the dates treated is given in the table below. Botanical analysis of the plots



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was made immediately preceding harvest on June 27. The ryegrass made more growth where the alfalfa was damaged by 2,4-D than in the other plots. Neither the yield nor the botanical composition of the alfalfa-ryegrass was affected by any of the 4-(2,4-DB) or DNBP treatments.

| | Relative yield of alfalfa-ryegrass first cutting, percent; estimated proportion of alfalfa in the hay, percent. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Height of alfalfa, inches, and dates treated | | | | | | | | | | | | | |
| 2,4-D lb/A | ½ Mar 21 | | 1 Mar 29 | | 2-3 Apr 6 | | 3-4 Apr 14 | | 10-14 Apr 26[a] | | 20-24 May 13[b] | | 24-28 May 26[b] | |
| | Y | P | Y | P | Y | P | Y | P | Y | P | Y | P | Y | P |
| ¼ | 98 | 95 | 99 | 95 | 98 | 95 | 92 | 55 | 99 | 95[a] | 84 | 71[b] | 79 | 70[b] |
| ½ | 103 | 95 | 102 | 95 | 98 | 71 | 77 | 25 | 100 | 95[a] | 70 | 12[b] | 68 | 17[b] |
| 1 | 102 | 95 | 105 | 72 | 76 | 32 | 72 | 1 | 95 | 80[a] | 59 | 4[b] | 70 | 8[b] |
| None | 100 | 95 | | | | | | | | | | | | |

[a] Heavy rains fell two hours after treatment and intermittently during the next 12 hours.

[b] Considerable proportion was dead alfalfa at harvest time.

(The Ohio Agricultural Experiment Station).

**Comparisons of 2,4-D and MCPA with 2,4-DB and MCPB on alfalfa and sweetclover undersown in wheat. Brown, D. A.** Part 1: Hay yields from plots treated in 1957. Herbicides used were: MCPA amine at 3 and 5 oz/A; MCPB and 2,4-DB sodium salts at 16 and 24 oz/A applied at two stages of growth (1) legume seedlings 2 inches (2) seedlings 5 inches high. Yields of alfalfa were extremely uniform. No significant difference was shown among chemicals, and treated plots equalled the checks in every respect. Sweetclover yields in tons per acre were variable. Averages were: checks 1.1; MCPA amine 0.82; MCPB sodium salt 0.56, and 2,4-DB sodium salt 0.26. Significant differences in yields of sweetclover occurred when MCPA amine was applied in excess of 3 oz/A; MCPB sodium salt in excess of 12 oz/A and 2,4-DB sodium salt in excess of 8 oz/A. Slightly less damage occurred when the chemicals were applied to plants at 5 inches rather than 2 inches in height. Part 2. A new experiment laid down in 1958 was designed to compare 2,4-D ester at 3 and 4 oz/A with 2,4-D and MCPA amines at 4, 6 and 8 oz/A and with 2,4-DB and MCPB esters and sodium salts at 16, 20, and 24 oz/A . Percent stand of alfalfa Sept. 1, average of all rates: MCPA amine 94; 2,4-DB ester 90; 2,4-DB sodium salt 87; MCPB sodium salt 84; 2,4-D amine 76; MCPA ester 70, and 2,4-D ester 67. At the lowest rates only 2,4-D ester significantly injured alfalfa plants but definite reductions occurred when 2,4-D and MCPA amines were applied at 6 oz/A; 2,4-DB ester at 24 oz/A; 2,4-DB and MCPB sodium salts at 20 and 24 oz/A and MCPB ester in excess of 16 oz/A. Sweetclover, as expected following 10 years of testing, was more sensitive to the chemicals than alfalfa. Compared with non-treated checks, percent stands, averaging all rates for each compound, Sept. 1, were as follows: MCPA amine 76; 2,4-DB sodium salt 71; 2,4-D amine 68; 2,4-D ester 68; MCPB sodium salt 55; MCPB ester 26 and 2,4-DB ester 20. Significant reduction in stand was inflicted by all compounds at all rates. Fair tolerance was shown to 2,4-D and MCPA amines at 4 oz/A; and to 2,4-D ester at 3 oz/A. The low rate of 16 oz/A for the butyrics was in excess of sweetclover tolerance, especially the ester formulations. (Canada Department of Agriculture, Experimental Farm, Brandon, Manitoba.)

**The response of established alfalfa to repeated applications of dalapon. Buchholtz, K. P.** Plots 15 by 50 feet in size were established in a 4-year-old stand of alfalfa infested with a moderate stand of quackgrass. On May 12, 1956, when the alfalfa was about 4 inches tall, dalapon was applied to certain plots at the rate of 2 and 4 lb/A. On October 6, 1956, additional plots were treated with dalapon at the two rates. In addition some plots treated with 2 lb/A of dalapon in the spring were retreated. On May 3, 1957, plots treated in the spring of 1956 were retreated with dalapon at the same rates as the previous year. The forage was harvested from the plots in July and in late August of both 1956 and 1957.

| | | | Dry forage yield, lb/A | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1956 | | 1957 | | Av. yield per year |
| Date of treatment | Dalapon appl. lb/A | Total appl. lb/A | 1st cut | 2nd cut | 1st cut | 2nd cut | |
| Spring | 2 | 4 | 2767** | 3030 | 2655** | 2561 | 5507 |
| | 4 | 8 | 1958** | 2983 | 2053** | 2127 | 4560 |
| Fall | 2 | 2 | ..... | ..... | 2889* | 2314 | 5203[1] |
| | 4 | 4 | ..... | ..... | 2565** | 2310 | 4875[1] |
| Spring and fall | 2 | 6 | 2943* | 3040 | 2631** | 2119 | 5367 |
| Check | .... | .... | 3504 | 2953 | 3782 | 2360 | 6300 |
| LSD 5% level | | | 459 | N. S. | 679 | N. S. | ..... |
| LSD 1% level | | | 635 | | 941 | | |

[1] Yield from 1 year only.

The quackgrass growth was reduced sharply by the 2 and 4 lb/A applications of dalapon. By the end of the second year quackgrass was nearly eliminated by the 4 lb/A applications made in the spring and by the 2 lb/A applications made in the spring and fall. The reduction in grass growth is reflected in part by the reductions in yields of forage. Spring applications of dalapon reduced yields of hay significantly in both 1956 and 1957. The 4 lb/A rate caused considerably more reduction than the 2 lb/ rate. The effects of fall treatments were observed only in 1957. Reductions in yields in the first cutting resulted from both 2 and 4 lb/A applications of dalapon. The growth of the alfalfa on plots treated with dalapon in the fall was very slow the next spring but eventually nearly normal growth occurred. In no case were reductions in yield noted in the second cutting of hay. Average hay yields were reduced by all treatments but a considerable part of this reduction was due to control of the quackgrass. It is probable that application of 4 lb/A of dalapon in the spring reduced growth of both grass and alfalfa significantly. (Department of Agronomy, University of Wisconsin, Madison.)

**Herbicides on seedling alfalfa and birdsfoot trefoil. Dowler, Clyde, and Willard, C. J.** Ranger alfalfa at 12 lb/A and a mixture of Empire and imported birdsfoot trefoil at 8 lb/A were bandseeded on April 15, 1958. German millet at 15 lb/A was sown as a grassy weed. Natural infestations of lambsquarters, redroot pigweed, ladysthumb smartweed, and field bindweed were present. All treatments were applied in triplicate in 40 gpa of water. Pre-emergence, April 15: EPTC at 2, 4, and 6 lb/A. Emergence: alfalfa April 15, birdsfoot trefoil May 12; dimethylamine salts of 4-(2,4-DB) and 4-(MCPB) at ½, 1, and 2 lb/A; sodium salt of dalapon at 1 and 2 lb/A; mixtures of dalapon at 2 lb/A and the phenoxybutyric acids at ½ and 1 lb/A; and alkanolamine salts of 2,4-D at ¼ and ½ lb/A. Two to four leaves; alfalfa May 17, birdsfoot trefoil, May 24: 4-(2,4-DB) and 4-(MCPB) at ½, 1, 2, and 4 lb/A; dalapon at 1, 2, and 4 lb/A; mixtures of dalapon at 2 lb/A and the phenoxybutyric acids at ½, 1, and 2 lb/A; 2,4-D at ¼ and ½ lb/A; and alkanolamine salts of DNBP at 4 and 8 lb/A.

EPTC at 4 and 6 lb/A gave good to excellent control of German millet with no injury to alfalfa or birdsfoot trefoil. The control of broadleaf weeds was erratic but EPTC at 4 and 6 lb/A generally gave good control of all weeds except smartweed. The emergence application of 4-(2,4-DB) and 4-(MCPB) at 2 lb/A gave good control of lambsquarters and redroot pigweed but poor control of other weeds. Dalapon gave excellent control of German millet. The combinations of dalapon and the phenoxybutyric acids gave excellent control of German millet, lambsquarters, and redroot pigweed. 2,4-D at ½ lb/A gave poor weed control and severe



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injury to alfalfa and birdsfoot trefoil. At the 2-4-leaf stage, 4-(2,4-DB) gave good to excellent control of the broadleaf weeds at 1 lb/A or above. 4-(MCPB) did not control field bindweed or smartweed. Dalapon gave excellent control of German millet as did the dalapon-phenoxybutyric acid combinations. The dalapon-phenoxybutyric acid mixtures gave the best over-all weed control. 2,4-D at ¼ lb/A did not seriously injure the legumes but gave poor weed control. At ½ lb/A, 2,4-D severely injured alfalfa, caused some injury to birdsfoot trefoil and gave good control of lambsquarters and redroot pigweed. Both rates of DNBP gave good weed control but caused severe injury to both alfalfa and birdsfoot trefoil. 4-(2,4-DB) alone or in combination with dalapon gave better weed control and caused less injury to alfalfa and birdsfoot trefoil than the same rates of 4-(MCPB). Alfalfa was injured more by 2,4-D than was birdsfoot trefoil. (Contribution of the Ohio Agricultural Experiment Station.)

**Control of annual grasses in spring-planted alfalfa. Elder, W. C.** Alfalfa was seeded on April 4th in soil heavily infested with seed from crabgrass and fall panicum. Herbicides was applied immediately after planting and at two weeks and four weeks after emergence. In the pre-emergence test, EPTC at rates of 4 and 8 lb/A eliminated all grasses for the season, and only a slight reduction in the alfalfa stand occurred in the heavier rate. Three lb/A of dalapon destroyed 50% of the grasses and reduced stands 20%. 4(2,4-DB) was ineffective on the grasses and 1 lb/A killed 80% of the alfalfa. Treatments made two and four weeks after emergence were too late to be effective on the heavy growth of grasses present. Alfalfa was not damaged by 4(2,4-DB) at rates of 2 lb/A. Mixtures of dalapon and 4(2,4-DB) appeared to damage alfalfa more than when used separately. (Contribution of the Agronomy Department, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma.)

**Formulations of phenoxyacetic and phenoxybutyric acids on alsike and red clover. Friesen, H. A.** The sodium salt and ester formulations of 4-(2,4-DB) and 4-(MCPB) at 0, 16, 20, and 24 oz/A and an amine of 2,4-D and MCPA each at 0, 4, 6, and 8 oz/A were sprayed in 6 gal/A of water in separate trials on alsike clover and Altaswede red clover. A split plot design with four replicates was used for each test. The clovers were seeded on May 28 without a companion crop and the herbicides were applied when the legumes had 3-5 true leaves. Lambsquarters was the predominant weed species but the infestation was very non-uniform. Control of lambsquarters was near complete as a result of all herbicide treatments. Dry weight of weeds from the alsike check plots was highly variable ranging from 300 to 1000 lb/A. Where the dry weight of weeds approached 1000 lb/A forage yields were increased by about 500 lb/A as the result of treatment with phenoxybutyric formulations. The weed infestation on the plots treated with the phenoxyacetic forms was much lighter and their removal resulted in no increase in forage yield. In the Altaswede red clover the trend of weed control and legume forage yield was similar but was further complicated by the incidence of powdery mildew. In both trials relatively large differences in forage yield due to treatment were noted but due to the great variability in the weed infestation none of the differences could be shown to be statistically significant. (Contributed by the Experimental Farm, Lacombe, Alberta.)

**Effect of different formulations of phenoxyacetic and phenoxybutyric acids on seedling legumes, assessed the year following seeding. Friesen, H. A.** On June 1, 1957 alfalfa and sweet clover were sown with and without a companion crop of oats. The crops were treated with the butyl ester and the sodium salt of 4-(MCPB) at 8, 16 and 32 oz/A; the butyl ester, amine, and sodium salt of 4-(2,4-DB) at 8, 16 and 32 oz/A; the alkanol amine of MCPA at 4 and 6 oz/A; an amine of 2,4-D at 3 oz/A; a 1:16 mixture of MCPA amine and 4-(MCPB) ester at 16 oz/A; when the alfalfa and sweet clover were in the 2 leaf stage. At the 5-leaf stage the amine of MCPA at 4 oz/A was applied. In 1957, the year of seeding, the 4-(2,4-DB) formulations were outstanding when assessed on control of annual weeds and yield of legumes, except with sweet clover where the heavier rates of the ester formulations of 4-(2,4-DB) and also 4-(MCPB) depressed the yield of forage. (1957 Research Report NCWCC, p. 105.)

In 1958 two cuts of alfalfa were taken. No significant difference due to treatment could be shown. However, the trend was for somewhat lower yields on the treated plots. With sweet clover the trend was to higher yields as the result of treatment with all amine and sodium salt formulations while treatment with ester formulations resulted in marked yield reductions. (Contributed by the Experimental Farm, Lacombe, Alberta.)

**Pre-emergence weed control in alfalfa and birdsfoot trefoil. Hollingsworth, E. B.** Ranger alfalfa and Empire birdsfoot trefoil were seeded in the spring in a well prepared seed bed. The following day four herbicides at two rates each were applied to the soil surface in 40 gal of water per acre (Table 1). The major objective was the control of weed grasses. Accordingly an early clipping was made to remove the first flush of broadleaf weeds. The yields shown in Table 1 are from one harvest approximately 8 weeks after the early clipping.

**Table 1. Effect on the yield of crop and associated weeds eight weeks after pre-emergence application of herbicides to alfalfa and birdsfoot trefoil.**

| | | Alfalfa | | Birdsfoot trefoil | | Weeds | |
|---|---|---|---|---|---|---|---|
| Herbicide | Rate (lb/A) | Yield (lb/A) | Plant wt. (g/pl) | Yield (lb/A) | Plant wt. (g/pl) | Grasses (lb/A) | Broad-leaf (lb/A) |
| EPTC | 8 | 2494 | 3.0 | | | 480 | 1319 |
| | | | | 1103 | 2.1 | 1391 | 2278 |
| EPTC | 12 | 2974 | 4.1 | | | 384 | 647 |
| | | | | 1631 | 3.1 | 1559 | 575 |
| TCA | 6 | 432 | 0.9 | | | 312 | 4412 |
| | | | | 216 | 0.5 | 120 | 5372 |
| TCA | 12 | 1151 | 2.1 | | | 600 | 1822 |
| | | | | 336 | 1.0 | 1030 | 1870 |
| Neburon | 2 | 168 | 1.0 | | | 24 | 10959 |
| | | | | 24 | 0.3 | 24 | 8681 |
| Neburon | 4 | 1271 | 2.1 | | | 48 | 6283 |
| | | | | 192 | 0.9 | 120 | 12661 |
| CDAA | 2 | 336 | 0.8 | | | 48 | 6762 |
| | | | | 72 | 0.3 | 240 | 5779 |
| CDAA | 4 | 264 | 1.1 | | | 72 | 6618 |
| | | | | 72 | 0.3 | 384 | 11582 |
| Check | | 288 | 1.0 | | | 0 | 5539 |
| | | | | 24 | 0.5 | 24 | 5515 |

The response of grass species to treatments was variable. A heavy infestation of crabgrass in the non-weeded check plot partially suppressed other grass species such as barnyardgrass, fall panicum and stinkgrass and lowered the total grass yield. All treatments controlled crabgrass to some extent. Neburon and CDAA failed to give satisfactory control of the larger species. Because of their size, barnyardgrass plants in a light infestation were capable of yielding as much or more dry matter than a heavier stand of crabgrass. Neburon and TCA provided good grass control early in the season, but they were more damaging to the legumes than EPTC and did not persist as long. Both rates of EPTC did a fair to excellent job of controlling all grass species. This was reflected in the higher yields of broadleaf weeds, which were able to take advantage of the reduced competition. Birdsfoot trefoil was not as effective as alfalfa in suppressing the development of broadleaf weeds following treatments with EPTC. The excep-

tionally high rates of EPTC were not deleterious to either alfalfa or birdsfoot trefoil.

(Contribution of the Indiana Agricultural Experiment Station, Lafayette, Indiana, and the Crops Research Division, A.R.S., U. S. Department of Agriculture.)

**Control of downy bromegrass in alfalfa. Hollingsworth, E. B.** Herbicides were applied to established alfalfa infested with downy bromegrass on three separate dates. All materials gave fair to excellent control of the bromegrass except 4 lb/A of CIPC applied in the fall. Best yields of alfalfa and good control of downy bromegrass resulted from fall treatments with 8 lb/A of CIPC and 2 lb/A of monuron. Yield reduction and injury to alfalfa were severe following treatment with 3 lb/A of simazin in the fall and early spring. Monuron and dalapon, when applied in the spring, reduced the yield of alfalfa. EPTC did not injure the alfalfa but gave only fair control of the bromegrass. The data indicate that fall aplpication of the materials usually was superior to spring application for control of downy bromegrass.

**Table 1. Yield of alfalfa on downy bromegrass following applications of herbicides on three dates to control downy bromegrass in established alfalfa. Yields taken May 17, 1958.**

| Herbicide | | Yield of plant material, lb/A | | | | | |
|---|---|---|---|---|---|---|---|
| | | Treated 10/3/57 | | Treated 3/15/58 | | Treated 4/9/58 | |
| Name | Rate lb/A | Alfalfa | Brome-grass | Alfalfa | Brome-grass | Alfalfa | Brome-grass |
| Monuron | 1 | 2902 | 408 | 1799 | 31 | 2045 | 96 |
| Monuron | 2 | 3021 | 48 | 1582 | 7 | 1223 | 96 |
| Simazin | 1½ | 2614 | 24 | 1702 | 17 | 2422 | 127 |
| Simazin | 3 | 1367 | 24 | 1391 | 0 | 2487 | 151 |
| CIPC | 4 | 3621 | 3357 | | | | |
| CIPC | 8 | 3069 | 96 | | | | |
| EPTC | 8 | | | 2110 | 199 | 2710 | 400 |
| Dalapon | 4 | | | 1559 | 0 | 1870 | 7 |
| CIPC | 3 | | | 2038 | 247 | 2415 | 360 |
| CIPC | 6 | | | 2421 | 79 | 2837 | 96 |
| None (control) | | 2782 | 1079 | 2152 | 823 | 2573 | 767 |

(Contribution of Indiana Agricultural Experiment Station, Lafayette, Indiana, and the Crops Research Division, A.R.S., U. S. Department of Agriculture.)

**The effect of herbicides on forage crops, 1958. Knowles, R. P. and Selleck, G. W.** New seedings of five grasses; brome, Fairway and Summit crested wheat, Intermediate wheat, and Russian wild rye, and two legumes, sweet clover and alfafa, were sprayed with a variable rate sprayer. Butyl esters of 2,4-DB, MCPB and MCPA, were applied at an initial rate of 8 lb/A in 35 gal of water. Single-space rows of each crop were sprayed in duplicate randomized blocks in late August, and readings of damage made in early September. Crops and weeds were 4 to 6 in high and growing vigorously when sprayed. Although spring seeded, crops germinated mainly after mid-July rains. None of the grasses showed noticeable damage from any herbicide at any rate. Alfalfa and sweet clover showed severe damage from MCPA at rates above 1 lb/A and appreciable damage at rates above 0.5 lb/A. Alfalfa showed good tolerance to 2,4-DB at 8 lb/A whereas sweet clover showed serious killing above 1 lb/A. MCPB killed alfalfa and sweet clover at rates in excess of 3 lb and 1 lb, respectively. Damage readings are subject to change depending upon recovery. The rates (lb/A) required to satisfactorily control redroot pigweed, portulaca, stinkweed and low amaranth are presented in the following table.

| Herbicide | Rate, lb/A, necessary to control | | | |
|---|---|---|---|---|
| | Amaranthus retroflexus | Portulaca oleracea | Thlaspi arvense | Amaranthus graecizans |
| MCPB | 1 | 2.1 | 0.3 | — |
| MCPA | 2.2 | 0.9 | 0.8 | 3.6 |
| 2,4-DB | 1.2 | 2.1 | 0.3 | 1.7 |

Established stands of crested wheat grass and bromegrass were treated with rates up to 8 lb/A 2,4-D amine in 1957 and germination of their seeds was not adversely affected. (Contribution from the Forage Crops Laboratory, Canada Department of Agriculture and Department of Plant Ecology, University of Saskatchewan, with financial assistance from the Saskatchewan Agricultural Research Foundation.)

**Chemical control of weeds in spring seeded alfalfa. Shafer, N. E.** Large, 1 to 4 acre blocks were treated using both airplane and ground spraying equipment. Chemicals and methods of application were as follows: pre-planting EPTC, 3 lb/A in 5 gal water by ground sprayer harrowed immediately with spike tooth harrow: pre-emergence EPTC at 3 and 6 lb/A in 5 gal water by airplane; post-emergence dalapon 2 lb/A plus 1 lb/A 4-(2,4-DB) ester in 5 gal water by airplane, and dalapon 2 lb/A plus ½ lb/A 4-(2,4-DB) amine in 5 gal water by ground sprayer. The pre-planting treatment was made April 21 and alfalfa was seeded April 22. Pre-emergence treatments were made April 26 following 1.3" rain on April 23 and 24. The 2 plus 1 post-emergence mixture was applied May 24 when most of the alfalfa had three expanded trifoliate leaves. The 2 plus ½ post-emergence mixture was sprayed June 10 when alfalfa had 5 to 6 expanded trifoliate leaves. Quadrats for hand separations of alfalfa and weeds were clipped during the period of July 8 to 11. Predominant weed species were annual smartweed and barnyard grass. Both of the dalapon-butyric mixtures caused a distinct contact type injury on the uppermost alfalfa leaves. This varied from marginal necrosis to complete leaf kill. The pre-planting treatment with EPTC resulted in some stunted seedling alfalfa plants while some showed interference with normal unfolding of the uppermost trifoliate leaf. Alfalfa subsequently recovered in both chemical treatments and produced normal growth.

| | Pounds dry matter per acre | | | |
|---|---|---|---|---|
| | Alfalfa | Forbs | Grasses | Total |
| 3 lb EPTC (incorporated) | 1370 | 246 | 80 | 1696 |
| 3 lb EPTC (pre-emergence) | 548 | 356 | 384 | 1288 |
| 6 lb EPTC (pre-emergence) | 536 | 328 | 358 | 1222 |
| 2 lb dalapon, 1 lb 4-(2,4-DB) ester | 368 | 100 | 3 | 471 |
| 2 lb dalapon, ½ lb 4-(2,4-DB) AS | 201 | 113 | 120 | 434 |
| Check | 324 | 390 | 482 | 1196 |

(Contribution of Agronomy Department, University of Nebraska, Lincoln, Nebr.)

**Chemical control of weeds in August seeded alfalfa. Shafer, N. E.** EPTC was applied by airplane at 1, 2, and 3 lb"A in 5 gallons of water as pre-planting soil incorporation treatments and at 6 lb/A as a pre-emergence treatment. Pre-planting treatments were made August 8 and immediately harrowed in with a spike tooth harrow. The field was seeded August 9 and the pre-emergence treatment was made August 15. All plots were 1.5 acres in size. Seedbed conditions were excellent with a dry soil surface but moist soil at a 2 to 3 inch depth. Quadrats for yield determinations were clipped September 17 approximately one month after emergence of the alfalfa. Both the 2 and 3 lb. pre-planting rates gave weed control equal to that obtained with 6 lb applied pre-emergence. The one lb rate gave some control of grasses and forbs but was not considered to be a practical treatment. Some injury was observed on the 6 lb pre-emergence plot while practically none occurred in the pre-planting plots. The following table gives results on forage production:

| | Pounds dry matter per acre | | | |
|---|---|---|---|---|
| | Alfalfa | Forbs | Grasses | Total |
| I lb EPTC, incorporated | 374 | 62 | 68 | 504 |
| 2 lb EPTC, incorporated | 282 | 2 | 6 | 290 |
| 3 lb EPTC, incorporated | 364 | 10 | 70 | 444 |
| 6 lb EPTC Pre-emergence | 306 | 22 | 11 | 339 |
| Check | 300 | 155 | 300 | 755 |

(Agronomy Department, University of Nebraska, Lincoln, Nebraska.)



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**The effects of pre-emergence and pre-planting herbicides on legumes. Peters, E. J. and Davis, F. S.** EPTC was applied pre-emergence at 5 and 10 lb/A and pre-planting at 1 and 2 lb"A to sericea lespedeza, Korean lespedeza, *Lespedeza daurica*, and crown vetch. Crown vetch also received treatments with dalapon and TCA at 3 and 8 lb/A respectively. All treatments were applied in 40 gallons of water on April 10, 1958. The pre-planting treatments were incorporated into the soil with a garden rake and seeding was done immediately.

Plant counts were made on May 31. Good stands of sericea lespedeza were obtained on all treated plots while no sericea lespedeza grew on the check plots. Korean lespedeza stands were slightly reduced by all treatments as compared with the check. *Lespedeza daurica* stands were nearly doubled on treated plots as compared to the check plots. Stands of vetch were nearly doubled with dalapon, TCA and with EPTC at 5 and 10 lb/A. Crown vetch plots treated with EPTC incorporated at 1 and 2 lb/A had better stands than plots receiving other treatments. (Contribution of the Crops Protection Research Branch, A.R.S., U. S. Department of Agriculture, and the Missouri Experiment Station cooperating.)

**Pre-planting and pre-emergence treatments with EPTC for weed control in red clover and birdsfoot trefoil. Peters, E. J. and Davis, F. S.** EPTC was applied pre-emergence to birdsfoot trefoil and medium red clover at rates of 5, 10 and 15 lb/A and as pre-planting treatments at 1 and 2 lb/A. The pre-planting treatments were sprayed onto a disked seed bed and incorporated into the soil by an additional disking within one-half hour after spraying. All plots were seeded on April 8, 1958 immediately following the additional disking. Pre-emergence treatments were applied the day of seeding. The experiment was replicated four times.

One hundred percent weed control was obtained for six weeks by the 1- and 2-lb pre-planting treatments of EPTC. After this period smartweeds and pigweeds became abundant. Crabgrass was controlled throughout the summer. Ten pounds of EPTC pre-emergence reduced the stand of weeds 60 percent while the 15 pound rate reduced the weed stand about 80 percent for about six weeks. Smartweeds and pigweeds came in abundantly after this time and crabgrass came in after the first cutting in mid-July. Control of weeds was unsatisfactory throughout the season at the 1-lb pre-emergence rate. Weed control was unsatisfactory from all treatments at the time the legumes were blooming in mid-July. In this extremely wet season, the effects of the herbicide on weeds disappeared before the red clover or birdsfoot trefoil had developed sufficiently to exert any appreciable competition. (Contribution of the Crops Protection Research Branch, A.R.S., U. S. Department of Agriculture, and the Missouri Agricultural Experiment Station cooperating.)

## HERBACEOUS WEEDS IN MEADOWS AND PASTURES

**Chemical control of star-flowered false Solomon's-seal. Sexsmith, J. J.** Single treatments of several herbicides were made to *Smilicina stellata* infesting an old established hay meadow and undisturbed rangeland in the foothills area of southwestern Alberta. Infestation of the plant was relatively dense in the hay meadow, quadrat counts showing a range of from 144 to 195 shoots per sq yd. Treatments with the following materials were made to sq-rd plots on May 29, 1958, when *S. stellata* was in full bloom; butyl ester of 4-(2,4-DB) at 4 lb/A; 1:1 mixture of butoxyethanol esters of 2,4-D and 2,4,5-T at 4 and 20 lb/A; dimethylamine of polychlorobenzoic acid (Benzac 354) at 40 lb/A; butyl ester of 2,4-D at 40 lb/A; BDM (DB granular, 90.5% Na tetraborate plus 7.5% 2,4-D) to supply 40 lb 2,4-D/A; and anhydrous borax (Concn. Borascu, 89% anhydrous Na tetraborate) at 3½ lb/100 sq ft. The first four materials were applied to undisturbed growth in 3 qt water per sq rod, whereas the BDM and borax were applied in dry form to mowed plots. Control estimates and notes were taken on August 7. Neither of the dry applications had completely killed the portions of shoots remaining after clipping prior to treatment. Grass growth was relatively unaffected by BDM but was reduced, delayed, and dried out by the borax. Although causing distortion, neither the 4-(2,4-DB) nor the Benzac 354 had killed top growth of *S. stellata* or affected the grasses. The 2,4-D-2,4,5-T mixture had given 90% top growth control at 4 lb and 99% control at 20 lb/A. At the heavy rate, grass stand was unaffected but was a deeper green color. 2,4-D at 40 lb/A had given 100% top growth control, and a slight reduction in stand and delay in heading of grasses, but the grass was a very deep green. (Canada Department of Agriculture, Experimental Farm, Lethbridge, Alberta.)

## SUGAR BEETS

**Pre-emergence herbicides in sugar beets. Andersen, Robert N.** Amer. 3S sugar beets were planted in a Waukegan silt loam at Rosemount, Minn., on May 6, 1958. Chemicals were applied alone and in combination with 6 lb/A of TCA as pre-emergence treatments. All were applied the day after planting except KOCN and DMA, which were applied 3 days after planting. Plots were left undisturbed and observation wes made periodically until July 21. In the first week of treatment, 0.05 inch of rain fell and in the second week, 0.58 inch. The dominant grass weed was *Setaria lutescens*, and a small amount of *Echinochloa crusgalli* was present. The dominant broadleaf weed was *Polygonum persicaria*, and there were less amounts of *Chenopodium album*, *Polygonum convolvulus*, *Ambrosia artemisiifolia*, and *Amaranthus retroflexus*.

TCA, 6 lb/A—Beets tolerant. Excellent control of grasses and *P. persicaria*. Poor control of other broadleaf weeds. The herbicidal action of TCA was not appreciably enhanced when it was applied in combination with other chemicals to which beets showed tolerance. Endothal, liquid and granular formulations at 4 and 8 lb/A—beets tolerant. Poor control of grasses and broadleaf weeds at both rates of both formulations. Neburon, 2 and 4 lb/A—Beets extremely susceptible at both rates. Poor weed control at 2 lb. Good to excellent control of grasses and most broadleaf weeds at 4 lb, becoming poor by July 21. EPTC, liquid and granular formulations at 3 and 6 lb/A—Beets tolerant at 3 lb of both formulations and 6 lb of liquid. Slight to moderate injury at 6 lb of granular. Poor weed control at 3 lb of both formulations. Fair grass control at 6 lb of liquid becoming poor by July 21. Good grass control at 6 lb granular becoming fair by July 21. Dimethylamine salt of trichlorobenzoic acid (Tryben), ½ and 2 lb/A—Beets extremely susceptible at both rates. Poor grass control at both rates. Excellent broadleaf control at 2 lb. Excellent control of *C. album* and *A. artemisiifolia* at ½ lb. CDAA, liquid and granular formulations at 3 and 6 lb—Moderate stand reduction at 3 lb and drastic stand reductions at 6 lb of both formulations. Poor broadleaf weed control except for good to excellent control of *A. retroflexus* at 3 and 6 lb of both formulations. Good grass control at 3 lb. Excellent grass control at 6 lb of both formulations. Alpha-chloro-*N*-ethyl-*N*-phenylacetamide, 3 and 6 lb/A—Beets tolerant at 3 lb with moderate stand reduction at 6 lb. Weed control similar to that with CDAA (Reaction on *A. retroflexus* not determined.) KOCN, 5 and 10 lb/A—No herbicidal effect on any species present. DMA 5 and 10 lb/A—No herbicidal effect on any species present. (Contribution of Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture and De-

partment of Agronomy and Plant Genetics, University of Minnesota, St. Paul. Paper No. 4009, Sci. Jour. Series, Minn. Agri. Exp. Station.)

**Pre-planting soil incorporation treatments for weed control in sugar beets. Andersen, Robert N.** Herbicides were applied to the surface of a Waukegan silt loam at Rosemount, Minn., on May 5, 1958. They were immediately incorporated and Amer. 3S sugar beets were planted. Plots received no further cultivation. In one experiment, incorporation was done by disking to a depth of 3-4 inches in 2 directions. In another experiment, incorporation was done by harrowing to a depth of 3-4 inches with a spike-tooth harrow with teeth set vertically. The dominant grass weed was *Setaria lutescens* but a small amount of *Echinochloa crusgalli* was present. The dominant broadleaf weed was *Polygonum persicaria* and there were much smaller amounts of *Chenopodium album, Polygonum convolvulus, Ambrosia artemisiifolia,* and *Amaranthus retroflexus* present. In the first week after treatment, 0.05 inch of rain fell and in the second week 0.58 inch fell. Data for both experiments have been combined in the table below. In both experiments, beets which survived even the most severe treatments recovered and grew vigorously.

**Herbicides on sugar beets. Bondarenko, D. D. and Haddad, G. A.** Sugar beets were planted in 32-inch rows in Toledo clay on April 1, 1958 (treated pre- and post-emergence) and on April 7 (treated preplanting) at the Northcentral Substation, Castalia, and in Hoytville silty clay loam on April 25 at the Northwest Substation, Hoytville. German millet was sown in all plots to simulate annual grasses. At Castalia the plots had a natural infestation of velvet leaf, common ragweed, and lambsquarters; at Hoytville, smartweed and common ragweed. Triplicate 4-row plots, 45 feet long, were treated overall with each rate of each herbicide. All gave excellent weed control, particularly of grasses, in all tests in which it was incorporated, with only slight retardation of the beets. Endothal gave fair control (50% reduction in stand) when incorporated, and had no effect on the beets. CDEC and CIPC, alone and mixed, were disappointing in all three tests. Both EPTC and endothal appear to be more effective herbicides when incorporated with the soil before sugar beets are planted, than when used in a standard pre-emergence application. Irrigation had no effect on their activities in this experiment. (Department of Field Husbandry and Botany, Ontario Agricultural College, Guelph, Ontario.)

| Treatment (lb/A) | Rating made June 11 | | | | | | | | Observations on July 21 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percent control | | | | Beet injury (0 = none 10 = kill) | | Beet-stand (% of check) | | Grass control | | Broadleaf control | |
| | Grass | | Broadleaf | | | | | | | | | |
| | D* | H | D | H | D | H | D | H | D | H | D | H |
| TCA 6 | 95 | 73 | 65 | 35 | 0 | 0 | 93 | 100 | E* | E | G* | G |
| Endothal 4 | 37 | 43 | 83 | 40 | 0 | 0 | 100 | 100 | P | G | G | F |
| Endothal 8 | 87 | 63 | 85 | 53 | 1 | 0 | 97 | 98 | G | G | G | G |
| Endothal gran. 4 | 33 | 17 | 50 | 17 | 0 | 0 | 100 | 100 | P | P | P | P |
| Endothal gran. 8 | 53 | 40 | 67 | 33 | 0 | 0 | 100 | 100 | F | F | G | F |
| EPTC 3 | 100 | 99 | 98 | 88 | 3 | 2 | 67 | 73 | E | E | G | G |
| EPTC 6 | 100 | 100 | 100 | 97 | 6 | 6 | 20 | 23 | E | E | E | G |
| EPTC granular 3 | 99 | 99 | 93 | 85 | 2 | 2 | 77 | 70 | E | E | G | G |
| EPTC granular 6 | 100 | 100 | 100 | 97 | 4 | 3 | 33 | 50 | E | E | E | E |
| CDAA 3 | 85 | 98 | 65 | 41 | 2 | 4 | 82 | 23 | E | E | P | P |
| CDAA 6 | 99 | 100 | 77 | 73 | 3 | 4 | 20 | 4 | E | E | P | P |
| CDAA granular 3 | 92 | 98 | 67 | 47 | 2 | 2 | 70 | 57 | E | E | P | P |
| CDAA granular 6 | 99 | 99 | 75 | 82 | 3 | 3 | 37 | 8 | E | E | P | P |
| Alpha-chloro *N*-ethyl-*N*-phenylacetamide 3 | 87 | 96 | 23 | 10 | 2 | 1 | 100 | 83 | E | E | P | P |
| 6 | 95 | 99 | 85 | 53 | 2 | 3 | 85 | 43 | E | E | F | P |

*D = disked
H = harrowed
E = excellent
G = good
F = fair
P = poor

(Contribution of Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture and Department of Agronomy and Plant Genetics, University of Minnesota. Paper No. 4008 Sci. Jour Series, Minn. Agric. Exp. Station.)

**Effects of pre-planting soil incorporation of herbicides on weeds in sugar beets. Bandeen, J. D., Switzer, C. M. and Jones, G. E.** Triplicate 4.5 x 20 ft plots were treated July 29 as follows: (1) herbicides were incorporated 2-3 in. deep followed by periodic irrigation, (2) herbicides were incorporated similarly but no irrigation was used (3.05 in. of rain fell the month following planting,) (3) herbicides were applied to the soil surface following planting. In (1) and (2) beets were planted immediately after incorporation. In all three, turnip and millet seeds were broadcast over the soil surface after the beets were planted to ensure a uniform "weed" population. The whole area was then cultipacked. Chemicals tested were CDEC (4, 6, and 8), EPTC (4, 6, and 8); endothal (4, 6, and 12); CIPC (2, 3, and 4) and mixtures of CDEC (4) and CIPC (2, 3, and 4). All rates are pounds per acre. Effects were estimated, and beets and weeds counted on Aug. 26. EPTC herbicides were applied in 40 gpa water except the granular materials, which were applied dry. Preplanting disked in immediately; April 1 at Castalia and April 19 at Hoytville: EPTC at 2, 4, and 6 (liquid) and 12 (granular) lb/A; DCU at 2, 4 and 6 lb/A; and endothal at 4, 6 (liquid) and 12 (granular) lb/A. In addition endothal was applied as above but disking did not follow until the date of planting. Pre-emergence; April 1 at Castalia and April 25 at Hoytville: dalapon, TCA and EPTC at 2, 4 and 6 lb/A, and EPTC granular at 12 lb/A. 2-4-leaf stage; May 11 at Castalia and May 20 at Hoytville: dalapon and TCA at 2, 4 and 6 lb/A. At Castalia the only sugar beets that showed herbicide injury, which was slight, at maturity were those treated pre-emergence with EPTC granular at 12 lb/A. At Hoytville prolonged wet weather and dense weed growth made thinning the beets unfeasible, so they were rated and then plowed on June 11.



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At Castalia EPTC at 6 and 12 lb/A pre-planting and at 12 lb/A pre-emergence reduced the stand of all species of weeds 90% or more. At Hoytville these EPTC treatments gave excellent control of millet and poor control of the broadleaf weeds. The following treatments at Castalia and Hoytville reduced the stand of millet 90% or more and gave little or no control of broadleaf weeds: EPTC at 4 lb/A and DCU at 4 and 6 lb/A pre-planting; dalapon, TCA and EPTC at 4 and 6 lb/A pre-emergence; and dalapon at 6 lb/A post-emergence. The other treatments gave fair to poor control of millet and little or no control of the broadleaf weeds. (The Ohio Agricultural Experiment Station.)

**Herbicides for weed control in sugar beets. Friesen, G.** The field selected for these experiments was near Rosenfield, Manitoba, and was heavily infested with wild oats and wild mustard. Plots were 14' x 77' in size, each containing eight rows of beets. Herbicides were applied with a variable dosage sprayer delivering 30 gallons of total solution per acre.

I. Pre-planting treatments. The herbicides were applied to the soil surface and mixed into the upper few inches of soil with a "cultro" followed by a packer. This was followed by seeding of beets the same day, May 26.

II. Pre-emergence treatments. The herbicides were sprayed on the soil surface immediately after seeding the beets on May 26.

III. Post-emergence treatments. Spraying was done on June 16, approximately 3 weeks after seeding. The sugar beets as well as most of the weeds had emerged. The treatments and results are presented in the following table:

| Herbicide | Rates used lb/A | Injury to beets | Weed control | |
|---|---|---|---|---|
| | | | Wild oats | Mustard |
| I. Pre-planting | | | | |
| Endothal | 1 to 16 | Considerable | Good | Good |
| IPC | 1 to 16 | Slight | Good | Poor |
| EPTC | 1 to 16 | Slight | Good | Fair |
| TCA | 1½ to 24 | Slight | Poor | Fair |
| CDAA | ½ to 8 | Considerable | Good | Poor |
| II. Pre-emergence | | | | |
| Endothal | 1 to 16 | Severe | Poor | Good |
| EPTC | 1 to 16 | Slight | Poor | Poor |
| TCA | 1½ to 14 | No injury | Poor | Poor |
| Dalapon | 1 to 16 | No injury | Poor | Poor |
| Simazin | ½ to 8 | Killed | Good | Good |
| III. Post-emergence | | | | |
| TCA | ½ to 8 | No injury | None | None |
| Dalapon | 1 to 16 | Considerable at higher rates | Fair at 7 lb/A and over | None |
| (S-847)* | ¼ to 4 | Slight | Excellent | Fair |

* 4-chloro-2-butynyl *N*-(3-chlorophenyl)carbamate

Pre-planting, IPC and EPTC gave good control of wild oats without appreciable injury to sugar beets. EPTC had the advantage of also giving some control of wild mustard. TCA gave poor weed control while endothal and CDAA were injurious to the beets. Pre-emergence treatments of the herbicides used hold little promise for the control of wild oats and wild mustard in sugar beets. Post-emergence, TCA gave no weed control at rates used. Dalapon at 7 lb/A and over gave good wild oat control but these rates caused considerable beet injury. Of particular interest was a new herbicide, S-847. At less than one pound per acre it gave excellent control of wild oats whereas no damage to beets was observed until the rate reached 2 lb/A. Partial control of wild mustard was also obtained. (Contribution from the Division of Plant Science, University of Manitoba.)

**Control of wild oats in sugar beets by pre-planting application of herbicides. Sexsmith, J. J.** Wild oats were seeded into a silty clay loam irrigated soil with a press drill and thoroughly disked on May 5, 1958. Two days later quadruplicate 8- by 22-ft plot areas were treated with chemicals as follows, applied in aqueous solution at 19.2 gpa: IPC, endothal, EPTC, and CDAA at 0, 4, 6, and 8 lb/A; and the sodium salt of TCA at 0, 10, 15, and 20 lb/A. Immediately after treatment the whole area was disked in two directions to a 3-inch depth and packed, and the sugar beets were seeded. Wild oat and beet counts were taken on June 4, thinning and weeding was done on June 23, and the beets were harvested on October 2 (two 22-ft rows per plot). Delay in thinning was necessitated by post-emergence treatments in the test area, and hail and high winds of June 27 caused serious damage to the spindly and recently-thinned beets. Wild oat control as determined by counts for the low, medium, and high rates, respectively, were: 76%, 86%, and 89% for IPC; 34%, 28%, and 42% for endothal; 92%, 99%, and 99% for EPTC; 20%, 50%, and 47% for CDAA; and 46%, 52%, and 70% for TCA. EPTC at 6 and 8 lb caused a stand reduction in unthinned beets of up to 45%, whereas none of the other materials caused serious stand reduction. Complete or near-complete thinned stands were obtained in all plots. None of the treatments appeared to affect root yields adversely. All treatment yields were above the untreated check yields, the reduced yields of check plots likely being due to the extended competition of wild oats before thinning. Sugar analyses indicated a very slight reduction in sucrose content of the roots from treated plots. (Canada Department of Agriculture, Experimental Farm, Lethbridge, Alberta.)

## WEED CONTROL IN TURF

**Silvex and 2,4-D on lawn weeds. Bondarenko, D. D.** Triplicate plots ½ rod by 1 rod of Kentucky bluegrass lawn infested with knotweed, broadleaf plantain, Rugel's plantain, dandelion, and white clover were treated with PGBE esters of silvex at 2 and 3 lb/A in 40 gal/A water on July 23, 1957. On October 15, 1957 all the plots showed 100 percent reduction in stand of the plantains, dandelion and white clover, and no damage to knotweed or bluegrass. Triplicate plots ½ rod by 1 rod infested with ground ivy were treated with alkanolamine salts of 2,4-D at ½ and 1 lb/A in 40 gpa water on June 29, 1957. On July 24, 1957 five plots varying in size from ½ sq. rod to 1 sq. rod in the same area as those above and infested with ground ivy were treated with PGBE ester of silvex at 2 lb/A in 40 gal/A water. On October 15, 1957 all the plots treated with silvex showed almost 100 percent kill of ground ivy; the plots treated with 2,4-D showed no damage to the ground ivy. Ground ivy was also treated with PGBE ester of silvex and alkanolamine salts of 2,4-D at ½, 1 and 2 lb/A in 40 gal/A water on October 1, 1957. On October 1, 1958 all the plots, regardless of treatment showed 95 to 100 percent reduction in stand of ground ivy. Triplicate plots ½ rod by 1 rod of bluegrass lawn infested with common chickweed were treated with PGBE ester of silvex at 1 and 2 lb/A in 40 gal/A water on April 22, 1958. A heavy rain fell 20 minutes after the silvex was applied. The chickweed plants in all the plots died within three weeks after treatment. On October 1 a few chickweed seedlings were present in the treated plots in spots where no bluegrass or crabgrass was growing. (The Ohio Agricultural Experiment Station.)

**Effects of FB-2, neburon and sodium arsenite on Kentucky bluegrass. Corns, Wm. G.** Grass seeded in July, 1957, was sprayed on July 17, 1958, 2 weeks after mowing, in triplicate 32 sq ft plots. Herbicides and rates of application were 1,1'-ethylene-2,2'-bipyridinium di-

bromide (FB-2) at 0, ½, 1, and 2 lb/A; neburon at 0, 2, 4, and 8 lb/A; sodium arsenite at 0, 1, 2, and 3 lb/A; each in 50 gal/A of water. Within a week after treatments, FB-2 areas were rather badly burned although regrowth occurred during the next several weeks. Neburon plots remained healthy apart from slight chlorosis from the 8 lb/A rate. Sodium arsenite plots were considerably injured and some grass treated with 3 lb/A died. The latter rate appeared inadequate for chickweed control (See elsewhere) hence neburon at about 4 lb/A seems preferable for control of this weed in bluegrass lawns and where creeping red fescue is present. (See another abstract.) (Division of Crop Ecology, Department of Plant Science, University of Alberta.)

**Tolerance of young creeping red fescue to neburon treatments. Corns Wm. G.** The grass was seeded on May 22, 1958, and on Aug. 13, 1958 duplicate sq yd plots were sprayed with neburon at 0, 2, 4, and 8 lb/A in 50 gal/A water. The grass was 6-7 in tall and had not been mowed. There was a slight tip burning and chlorosis from the 4 and 8 lb/A rates but by the end of the season, no grass was killed. On the basis of associated experiments it appears practical to use 4 lb of this chemical /A for control of chickweed in lawns containing bluegrass and red fescue. (Division of Crop Ecology, Department of Plant Science, University of Alberta.)

**Post-emergence herbicides for crabgrass control in bluegrass turf. R. R. Davis.** An unirrigated bluegrass sod was used for the test area. All treatments were applied as an aqueous spray at the rate of 2.3 gal/1000 sq ft. Applications were made 1 week apart. The plot size was 100 sq ft. The degree of control was estimated by sampling five areas of 1 sq ft on each plot. **Early post-emergence.** The first application was made June 12, 1958 when crabgrass was in the 3 to 4 leaf stage. DMA and octyl-dodecyl ammonium methyl arsonate (AMA) at both rates killed the original crabgrass with two applications with no injury to bluegrass. Continued germination of crabgrass, mostly in earthworm casts, made additional applications necessary. Phenylmercuric 8-hydroxyquinolinate at both rates seriously injured bluegrass. **Late post-emergence.** The first application was made August 5. Crabgrass was in the heading stage. Bluegrass was not damaged at either rate of DMA or AMA. There was no advantage for the higher rate.

Percentage of area covered by crabgrass, Oct. 8

| Early post-emergence | | | | Late post-emergence | | | |
|---|---|---|---|---|---|---|---|
| Herbicide | Rate oz/1000 sq ft | No. applications | Pct. | Herbicide | Rate oz/1000 sq ft | No. applications | Pct. |
| DMA | 2.1 | 4 | 10 | DMA | 2.1 | 3 | 0 |
| DMA | 1.05 | 4 | 9 | DMA | 1.05 | 3 | 7 |
| AMA | 1.6 | 3 | 11 | AMA | 1.6 | 3 | 0 |
| AMA | 0.8 | 4 | 7 | AMA | 0.8 | 3 | 2 |
| Phenylmercuric 8-hydroxyquinolinate | | | | | | | |
| | 0.4 | 2 | 42 | Check | | | 82 |
| | 0.2 | 3 | 23 | | | | |
| Check | | | 91 | | | | |
| LSD 5% | | | 14 | LSD 5% | | | 9 |
| 1% | | | 19 | 1% | | | 12 |

(The Ohio Agricultural Experiment Station.)

**Pre-emergence crabgrass control in golf fairways. Rogers, B. J.** Dry formulations of chlordane (75 lb/A), lead arsenate (670 and 840 lb/A), and NPA (13.5 lb/A) were applied April 12 to a Kentucky bluegrass fairway which had been infested with crabgrass the previous year. The area of ground covered by crabgrass plants on October 11, as percent of total area, was as follows: chlordane, 16; 670 lb lead arsenate, 8; 840 lb lead arsenate, 11; NPA, 60; check, 41. Due to variations in the initial crabgrass infestation, there probably is no significant difference between the chlordane and the lead arsenate plots. It appears that the NPA may have retarded the blugrass and allowed more crabgrass growth, although there was no visible injury from the NPA. Over a 4-year period chlordane at 75-100 lb/A has given good to excellent pre-emergence crabgrass control; lead arsenate at 550 to 840 lb/A has been equally effective. (Department of Botany and Plant Pathology, Agricultural Experiment Station, Purdue University.)

## WEED CONTROL IN HORTICULTURAL CROPS

### VEGETABLES

**Pre-emergence application of herbicides for weed control in potatoes. Brown, D. A.** Treatments were DNBP and dalapon at 3 and 5 lb/A and the butyl ester of MCPB at 16 and 32 oz/A. Applications were made several days before potato stems broke the surface. Sustained drouth through the early growing season held weeds in check, but sufficient growth came late in June to reflect the benefit of the treatments. DNBP at 5 lb/A gave excellent control of all broad-leaved weeds but green foxtail prevailed. Dalapon gave only medium control of both broad-leaved and grassy weeds. MCPB gave 40 percent control of broad-leaved weeds which consisted mainly of pigweeds and stinkweed. At best it could be said that control of weeds by the herbicides was helpful merely in reducing by 50 percent the tillage required to keep weeds under complete control. None of the chemicals visibly injured the potatoes. (Contribution from Canada Department of Agriculture, Experiment Farm, Brandon, Man.)

**Pre-emergence weeding of ten vegetables. Dabbs, D. H. and Forsberg, D. E.** Duplicate plot trials of SMDC (Vapam) and EPTC, both at 5 lb/A, and simazin at 2 lb/A were conducted on ten vegetables in 1958. Residual effects from a 1957 trial plot were also studied. Simazin and EPTC were applied immediately following seeding of the vegetables, and SMDC fifteen days prior to seeding. Weed counts on June 17 (per 2500 sq in) were: EPTC, residual, 22, 1958, 14; check, residual, 21, 1958, 30; simazin, residual, 38, 1958, 22; SMDC, residual, 11, 1958, 13. The entire block was hand weeded shortly after and weed counts taken on August 27 were: EPTC, residual, 19, 1958, 9; check, residual, 24, 1958, 16; simazin, residual, 38, 1958,2; SMDC, residual 16, 1958, 10. EPTC (1958) caused a certain amount of early season distortion to pea leaves, almost completely eradicated young lettuce plants, somewhat adversely affected the beets, almost annihilated the onion crop and the cucumber crop. Simazin (1958) was quite destructive to young lettuce plants and beet plants, caused some burning of foliage on young tomato plants, a number of deformities in carrot roots, and stunting and size variation in onion bulbs. All vegetables performed well in the 1958 SMDC block. Radishes succumbed almost completely in the 1957 SMDC plot, cucumbers performed very poorly in the 1957 simazin block. All vegetables, where not specifically mentioned, developed as nearly normally as the extremely dry growing season would permit. (Contribution from Experimental Farm, Scott, Saskatchewan.)

**Effect of 2,4-D on tomatoes downwind from the sprayer. Dabbs, D. H. and Forsberg, D. E.** This trial, which was conducted in 1956 and 1957, was repeated in 1958 in an effort to obtain additional information. The same treatments, as reported in 1957, were used in 1958. The potted plants were subjected to the 2,4-D ester spray drift on June 24. The wind speed was 15 mph, and the sprayer was operated for thirty minutes at an application rate of 5 oz acid/A. The table shows the effects on yields for 1956, 1957 and 1958.



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**Yields of fruit from tomatoes subjected to 2,4-D drift.**

| | Ripe fruit Av. yield/rep., lb | | | Green fruit Av. yield/rep., lb | | |
|---|---|---|---|---|---|---|
| Treatment | 1956 | 1957 | 1958 | 1956 | 1957 | 1958 |
| 0-rods | 0.4 | 0.0 | 0.3 | 1.1 | 0.0 | 0.0 |
| 2-rods | 1.7 | 0.1 | 0.8 | 2.2 | 0.2 | 5.6 |
| 4--rods | 1.7 | 0.1 | 1.1 | 3.1 | 1.4 | 4.7 |
| 12-rods | 1.9 | 0.9 | 1.8 | 2.4 | 4.9 | 5.8 |
| 24-rods | 1.6 | 2.6 | 1.6 | 2.6 | 8.1 | 5.9 |
| 48-rods | 2.1 | 3.6 | 1.6 | 2.7 | 6.4 | 6.3 |
| 96-rods | 1.7 | 3.2 | 2.0 | 2.1 | 5.7 | 7.0 |
| Check | 1.8 | 2.5 | 1.5 | 2.2 | 2.8 | 3.5 |

1956-ripe-LSD (5%)=0.71 lb;
1957-ripe-LSD (5%)=0.84 lb; Green-LSD (5%)=2.93 lb;
1958-ripe-LSD (5%)=0.57 lb; Green-LSD (5%)=2.45 lb;

The yield picture is obvious from the above table. In 1956, all plants from the 0-rods treatment were severely distorted for the first three weeks. Following this date, recovery was quite good for replicates 1 and 3. Most of the field-ripened fruit from the five treatments closest to the path of the sprayer were seedless and the skin over the entire stem end was severely russeted and often badly cracked. In 1957 all 0-rod plants succumbed, and the 2-rod and 4-rod plants were very poor. There was some skin russeting, but an apparent increase in yield of green fruit for the 24, 48 and 96-rod treatments over that of the check. In 1958 the first harvest of ripe fruits showed severe russeting at 2-rods, with diminishing severity to the 96-rod distance. The 0-rod plants were essentially ruined. There was again an apparent increase in yield of green fruit at the 48 and 96-rod distances over that of the check. (Contribution from Experimental Farm, Scott, Saskatchewan.)

**Effect of 2,4-D on tomatoes upwind from the sprayer. Dabbs, D. H. and Forsberg, D. E.** This trial was conducted in 1958, in an effort to determine if there was any effect whatever on tomato plants growing upwind from a field sprayer applying 2,4-D ester. Early Chatham tomato plants, growing in 5 inch clay pots, were arranged in the field at distances of 0, 2, 4, 12, 24, 48 and 96 rods upwind from the path of the field sprayer on June 23. A check treatment was also included. The wind speed was 15 mph and the sprayer was operated for thirty minutes at an application rate of 5 oz acid/A. The statistical treament used was a randomized block design with four replications. The only effect was on the plants at the 0-rods distance. Early season growth on this treatment was somewhat distorted, but recovery was quite rapid. Some skin russeting was noted on first ripe fruits from the 0-rods treatment. There were no significant differences in yields of ripe fruit or green fruit. (Contribution from Experimental Farm, Scott, Saskatchewan.)

**Pre-emergence herbicides for weed control in transplanted tomatoes. Friesen, G.** The commercial production of tomatoes in Manitoba is gaining popularity. Weed control in this crop is entirely by hand-hoeing. Tomato plants started in the greenhouse were transplanted to the field on June 20. On June 23 four herbicides: simazin, 2-chloro-4-isopropylamine-6-methylamino-*s*-triazine (G-30026), 2-chloro-4-isapropylamino-6-ethylamino-*s*-triazine (G-30027), and EPTC, were applied on test plots. All herbicides were applied at rates varying from 1 to 4 lb/A in 90 gal of water using a variable dosage sprayer. The plots were sprinkler irrigated as required for normal tomato plant development. All the triazine compounds proved lethal to the tomato plants. Even at the lowest dosages no plants survived. EPTC, however, proved non-toxic to the crop and resulted in excellent control of weeds (mainly redroot pigweed and lambsquarters) in this experiment. (Contribution from the Division of Plant Science, University of Manitoba, Winnipeg.)

**Control of some perennial weeds growing in asparagus. McCurdy, E. V.** An old stand of asparagus severely infested with Canada thistle, sowthistle, dandelion and couchgrass was divided into plots. Amitrol at 8 lb/A was applied alone and in combination with mixed esters of 2,4-D (Weedar 80) at 1 lb/A, dalapon at 20 lb/A and dalapon at 20 lb/A plus 2,4-D at 1 lb/A, simazin at 2 lb /A and tris-(2,4-dichlorophenoxyethyl) phosphite (3Y9) at 4 and 6 lb/A were applied on April 24, before most weeds had emerged. Little was accomplished by this early application. The above chemicals, with the exception of simazin and 3Y9, were reapplied to the same plots on May 26 when the broadleaved weeds were making active growth. The amitrol at 8 lb/A retarded the Canada thistle and couchgrass but had little effect on sowthistle. This rate caused slight injury to the asparagus. Little was accomplished with the 2,4-D but the grass was retarded with the dalapon. On July 11, amitrol was again applied but at 12 and 16 lb/A, to plots previously treated with amitrol. At 12 lb/A Canada thistle was severely retarded and at 16 lb/A was effectively controlled. At both rates asparagus suffered only minor injury. 2,3,6-Trichlorobenzoic acid (Benzac 1281) at 12 lb/A, applied in July, severely injured the Canada thistle but also slightly injured the asparagus. A mixture of chlorinated benzoic and cresoxyacetic acids (CP1815), also applied in July, was not effective on the perennial weeds in this test. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

**Pre-emergence weed control in bush beans, 1958. Nylund, R. E., Nelson, D. C., and Dinkel, D. H.** Topcrop beans seeded in muck soil on May 5 were sprayed on May 9, prior to emergence, with the following herbicides (rates per acre): 6 lb DNBP amine, 4 and 6 lb CDAA, 2 and 4 lb CDAA-S (solventless CDAA), 10 lb 2-chloro-*N*-ethyl-*N*-phenylacetamide (CP 6936), 8 lb CIPC, 1.6 lb monuron, and the mixtures 0.8 lb monuron plus 6 lb DNBP amine, and 0.8 lb monuron plus 4 lb CDAA. Each of the herbicides was applied at 30 psi pressure in 80 gal/A water to single-row plots 18' long and replicated five times. Air temperature at the time of spraying was 64° F., humidity was 22%, and the soil surface was dry. No rain fell during the six days preceding herbicide application and the temperatures averaged 61° F. Following herbicide application temperatures averaged 67° F. for the first week. A rain of 1.13" was recorded on the 8th day following application of herbicides. Weeds, which emerged after herbicide application, were present in the following proportions: 47% annual grasses (mostly *Setaria* spp.), 47% purslane, 4% pigweed, and 2% shepherd's purse. Weed control was rated three weeks after spraying. Due to a severe late spring frost which damaged most of the planting, no yield data were obtained. However, to the time of the frost no injury due to herbicide treatments was apparent. All of the herbicides gave statistically significant broad-leaved weed control, and all except DNBP amine and monuron plus DNBP amine gave significant grass control although CDAA, CDAA-S, CP 6936, and the monuron-CDAA mixture were considerably more effective than the other herbicides. In over-all weed control only the following herbicides gave commercially acceptable control: 4 and 6 lb CDAA and 0.8 lb monuron plus 4 lb CDAA. (Paper No. 3998 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.)

**Pre-emergence weed control in muckland potatoes, 1958. Nylund, R. E., Nelson, D. C., and Dinkel, D. H.** Cherokee potatoes planted in muck soil on April 21 were sprayed on May 5 with the following herbicides: 6 lb DNBP amine, 1.6 and 2.5 lb monuron, 6 lb CDAA, 6 and 8 lb alpha-chloro-*N*-ethyl-*N*-phenylacetamide (CP 6936), 1 and 2 lb simazin, 2 lb 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine (G-27901), 10 lb EPTC, and 2 and 6 lb 2,5-dichloro-3-nitrobenzoic acid, Na salt (ACP-M503), and the mixtures 2 lb 2,4-D (propylene glycol butyl ether ester) plus 10 lb TCA (Na salt) and 6 lb DNBP amine plus 10 lb TCA (Na salt). The herbicides were applied at 30 psi pressure in 80 gal water per acre to single-row plots 18' long in each of five replicates. Neither potatoes



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nor weeds had emerged at the time of spraying. The weed population which later emerged in the control plots consisted of 40% lambquarters, 40% shepherd's purse, 15% foxtails, and 5% pigweed. Temperature at spraying was 45° F., humidity was 30%, and the soil was moist. During the week following spraying, temperatures averaged 6 degrees above the normal, 55° F. No rain fell until the 12th day following spraying (May 17), when 1.13" was recorded. Weed control and potato injury were recorded 24 days after spraying and potato injury was recorded again 14 days later. Yields were obtained at harvest on September 6. Of the 15 herbicides applied, only 2.4 lb monuron and the mixtures of 2,4-D and DNBP amine with TCA gave acceptable weed control. These herbicides gave fairly good control of both grasses and broad-leaved weeds. CDAA at 6 lb and 6 lb CP 6936 gave fair grass control but unsatisfactory broad-leaved weed control. Observations 38 days after spraying showed that CP 6936 caused slight injury and 6 lb ACP-M503 caused moderately severe injury to the potato plants. These injuries, however, did not affect potato yields, which did not differ significantly for any of the treatments. (Paper No. 3999 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.)

**Pre-emergence weed control in established asparagus. Nylund, R. E. and Nelson, D. C.** Established asparagus on muck soil was disced on April 16 and sprayed with the following herbicides on April 30 (rates per acre): 3 lb monuron, 4 lb 2,4-D (propylene glycol butyl ether ester), 2 and 4 lb amitrol, 2 and 4 lb simazin, and a mixture containing 4 lb 2,4-D plus 10 lb TCA (Na salt). Each of these were applied at 30 psi pressure in 40 gal water per acre to plots 4' wide by 33' long in each of six replications. At the time of spraying the temperature was 55° F. and the soil was wet. Canada thistle and a few smartweed plants were emerging; lambsquarters, which were abundant later, had not begun to emerge. Temperatures averaged 5 degrees below the normal 55° F. during the first week and 6 degrees above normal during the second week following spraying. The asparagus was not harvested nor cultivated during the summer. Weed control and asparagus injury ratings were made four weeks after spraying. All of the herbicides gave good weed control with only slight injury to the asparagus being caused by the amitrol, 4 lb simazin, and the 2,4-D-TCA mixture. Only the 4 lb rate of amitrol gave any degree of Canada thistle control. Observations made six weeks after spraying showed that all the herbicides except 4 lb 2,4-D and 3 lb monuron killed most of the weeds except Canada thistle. The 2,4-D alone killed all weeds except the smartweeds and Canada thistle. The most effective herbicides were 4 lb amitrol, 4 lb simazin, and the 2,4-D-TCA mixture. (Paper No. 4000 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.)

**Pre-emergence weed control in asparagus seedbeds. Nylund, R. E. and Nelson, D. C.** On May 19, 1958 asparagus seed was planted in a silty clay loam soil, and on June 2 the following herbicides were applied to plots 4' wide by 16½' long replicated four times: 80 gal Stoddard solvent, 3 lb DNBP amine, 2 lb 2,4-D (propylene glycol butyl ether ester), 2 lb simazin, and 2 lb monuron per acre. All were applied at 30 psi pressure. At the time of spraying none of the asparagus seed had started to sprout and only a few broad-leaved weeds were emerged. The temperature on the day of spraying was 70° F. and the humidity 100% (occasional drops of rain fell during spraying). Rainfall totalled 2.48" during the two weeks following spraying. Asparagus seedlings began to emerge about June 18. Weed control was rated on June 11 and again on June 25, when asparagus injury was also recorded. The weed species present were principally smartweeds with some barnyardgrass and a scattering of lambquarters and pigweed. All of the herbicides gave some weed control but the simazin- and monuron-treated plots were weed-free on June 25 and remained so at least until July 16, six weeks after spraying. Both of these herbicides caused only slight temporary injury to the asparagus seedlings while the 2,4-D caused moderate to severe injury. (Paper No. 4001 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.)

**The relative tolerance of four onion varieties to four pre-emergence herbicides. Nylund, R. E., Nelson, D. C., and Dinkel, D. H.** One inbred onion variety (Brigham Yellow Globe) and three hybrids (Elite, Aristocrat, and Epoch) were seeded in muck soil on April 18 and sprayed on April 28 with the following herbicides (rates per acre): 1.6 lb monuron, 8 lb CIPC, 6 lb. CDAA, and a mixture containing 4 lb CIPC and 2 lb CDAA. Each of the herbicides were applied at 30 psi pressure in 80 gal water per acre to single-row plots 18' long randomized within each of the variety blocks which, in turn, were randomized within each of five replications. Each variety sub-block also contained an unsprayed plot. The temperature at time of spraying was 47° F., the humidity 66%, and the soil was wet. Temperatures during the week following herbicide application averaged 48° F. During the first 12 days following herbicide application the only rainfall recorded was 0.58" 4 days after spraying. At the time of spraying onions had sprouts to ¼" long, but onions did not begin to emerge until 10 days after spraying. Weeds, all of which emerged after herbicide application, were 72% annual grasses (mostly *Setaria* spp.) and 28% annual broad-leaved weeds (approximately 50% *Capsella bursa-pastoris* and 50% *Portulaca oleracea*). Weed control and onion injury were rated three weeks after spraying. Onion yields were recorded on September 5. The four onion varieties did not show differential tolerance to the herbicides. None showed injury, and no yield differences between herbicide treatments were obtained in any of the varieties. The varieties differed in yield, the average yields per 18' row being 42 pounds for Elite, 36 for Brigham Yellow Globe, 33 for Aristocrat, and 32 for Epoch. All of the herbicides except CIPC gave some weed control. However, CDAA was the only herbicide which gave satisfactory weed control. (Paper No. 4002 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.)

**Pre-emergence weed control in muckland onions, 1958. Nylund, R. E., Nelson, D. C., and Dinkel, D. H.** Brigham Yellow Globe onions seeded in slightly acid (pH 6.2) muck soil on April 18 were sprayed on April 28 with the following herbicides (rates per acre): 1.6 lb monuron, 8 lb CIPC, 4 and 6 lb CDAA, 6 and 8 lb alpha-chloro-*N*-ethyl-*N*-phenylacetamide (CP 6936), 1 and 2 lb simazin, 1 and 2 lb 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine (G-27901), and mixtures containing 0.8 lb monuron plus 2 lb CDAA, and 4 lb CIPC plus 2 lb CDAA. One granular herbicide was applied dry: 8 lb CIPC formulated as a 5% granular. Each of the liquid herbicides was applied at 30 psi pressure in 80 gal water per acre to 18' single row plots replicated five times. The temperature on the application date was 47° F., the humidity 66%, and the soil was wet. Temperatures during the week following herbicide application averaged 48° F. During the first 12 days following herbicide application the only rainfall recorded was 0.58" 4 days after spraying. At the time of spraying onions had sprouts to ¼" long. The first onions emerged 10 days after and all had emerged 13 days after spraying. Weeds, all of which emerged after herbicide application, were 72% annual grasses (mostly *Setaria* spp.) and 28% annual broad-leaved weeds (approximately 50% *Capsella bursa-pastoris* and 50% *Portulaca oleracea*). Weed control and onion injury were obtained by comparing each treated row with an adjacent untreated row. Such ratings were made 21 days after herbicide application after which all plots were kept weed-free by hand weeding. Onion yields were recorded at maturity on August 20. All of the herbicides except G-27901 and granular CIPC gave some weed control. However, only the following gave



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commercially acceptable weed control: 4 and 6 lb CDAA, 6 lb CP 6936 and the mixtures of monuron-CDAA and CIPC-CDAA. The mixtures were slightly less effective in controlling bread-leaved weeds than were the other herbicides, but all six gave good grass control. No onion injury was observed and none of the treatments significantly reduced yields. (Paper No. 4004 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.)

**Weed control in a vegetable garden with soil fumigants. Nylund, R. E., and Turnquist, O. C.** On April 22, two fumigants—DMTT (Mylone 50D) and SMDC (Vapam 4S)—were applied to 10′ x 10′ plots in each of four replicates on Waukegan silty clay loam soil. DMTT was broadcast by hand at ⅔ lb per 100 sq ft, and the SMDC was applied from a sprinkling can at 1 lb (1 quart) in 4 gal water per 100 sq ft. Both were then watered in, using 8 gal water per 100 sq ft. Two weeks after fumigant application (May 5) all plots were rototilled, allowed to stand one week, and then seeded (May 12) with rows of sweet corn (Sugar and Gold), garden peas (Perfection Freezer and Little Marvel), bush beans (Tendergreen Improved), carrots (Nantes), and onions (Brigham Yellow Globe). One month after seeding (June 10), weed control and crop injury was rated in comparison with untreated plots in each replicate. No weeds emerged in the DMTT plots and weed control in the SMDC plots was rated between fair and good. Both fumigants, however, caused slight to moderate stunting of the seeded vegetable crops. DMTT apparently caused slightly more injury to bush beans and sweet corn than SMDC, while the latter caused slightly more injury to onions and carrots. This injury may have been due to failure of the fumigants to become inactivated rapidly enough under the relatively low mean temperature (48° F) which prevailed for the first two weeks after application. Temperature between rototilling and seeding averaged 61° F. No yields were recorded in this preliminary study. (Paper No. 4006 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.

**Early post-emergence weed control in muckland onions, 1958. Nylund, R. E., Nelson, D. C., and Dinkel, D. H.** Brigham Yellow Globe onions seeded in muck soil on April 18 were sprayed at the one-leaf stage on May 21 with the following herbicides (rates per acre): 4 and 6 lb CDAA, 1.6 lb monuron, 8 lb CIPC, 1 and 2 lb simazin, 2 lb 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine (G-27901), 6 and 8 lb alpha-chloro-*N*-ethyl-*N*-phenylacetamide (C.P. 6936), and the mixtures 0.8 lb monuron plus 2 lb CDAA, 0.8 lb monuron plus 4 lb CIPC, and 2 lb CDAA plus 4 lb CIPC. In addition one granular herbicide was applied dry: 8 lb CIPC formulated as a 5% granular. Each of the liquid herbicides was applied at 30 psi pressure in 80 gal water per acre to 18′ single-row plots replicated five times. A single-row plot was left untreated adjacent to each treated plot. The temperature at the time of herbicide application was 64° F., humidity 30%, and the soil surface was dry. Air temperature during the week preceeding spraying averaged 67° F. and during the week following spraying, 63° F. Three days before spraying 1.13″ rain was recorded, but only 0.03″ on the 3rd day and 0.10″ on the 10th day following spraying was recorded. At the time of spraying annual grasses (*Setaria* spp.), which made up 72% of the weed population, were in the two-leaf stage. Shepherds purse, purslane, and smartweeds were in the early two- to three-leaf stage. One week after spraying onions treated with the following herbicides showed slight injury: 6 lb CDAA, 8 lb CIPC, and the mixtures of monuron with CDAA and CIPC. This injury was not reflected in final onion yields, however, which were not reduced by any of the treatments. While all of the treatments except 4 lb CDAA, simazin, and the CDAA-CIPC mixture gave some weed control, the only herbicides which gave commercially acceptable weed control two weeks after treatment were the monuron-CIPC mixture, the monuron-CDAA mixture, and 8 lb CIPC. (Paper No. 4007 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.

**Late post-emergence weed control in muckland onions, 1958. Nylund, R. E., Nelson, D. C., and Dinkel, D. H.** Brigham Yellow Globe onions seeded in muck soil on April 18 were sprayed on July 8 (one week after the lay-by cultivation) with the following herbicides (rates per acre): 1.6 lb monuron, 8 lb CIPC, 4 lb CDAA, and the mixtures 0.8 lb monuron plus 2 lb CIPC, 0.8 lb monuron plus 4 lb CIPC, 0.8 lb monuron plus 4 lb CDAA, and 2 lb CDAA plus 4 lb CIPC. All herbicides were applied as basal sprays at 30 psi pressure in 80 gal. water per acre to 18′ single-row plots replicated five times. A single-row plot was left untreated adjacent to each treated plot. The temperature at the time of treatment was 62° F., the humidity was 52%, and the soil was very dry, no rain having fallen since July 4 when 0.28″ was recorded. Temperature during the week preceding spraying averaged 68° F. and during the week following spraying, 65° F. On the day following spraying, 1.10″ rain fell and an additional 0.05″ was recorded six days after spraying. The few broad-leaved and grass weeds present at the time of spraying were 4 to 8″ tall. Weed control and onion injury were rated three weeks after spraying, and yields were recorded at harvest on August 20. None of the herbicides caused observable onion injury and this was verified by the yield data which showed no significant differences in yields from any treatments. All of the herbicides gave some weed control but the only ones which gave acceptable weed control were 8 lb CIPC and the mixtures of monuron with CIPC or CDAA. (Paper No. 4003 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.

**Pre-emergence weed control in onions on six organic soils, 1958. Nylund, R. E., Nelson, D. C., and Dinkel, D. C.** Six organic soils in the Hollandale, Minnesota, area, which varied in acidity from pH 6.0 to 7.7 and in organic matter content from 26 to 70%, were selected to determine the differential responses of weeds and onions to pre-emergence herbicides. Seeded Trapp's Yellow Globe onions on each of these soils were sprayed before emergence with the following herbicides: 0.8 and 1.6 lb/A monuron, 6 and 8 lb CIPC, and 4 and 6 lb CDAA. The herbicides were applied at 25 psi pressure in 40 gal water per acre to plots 4′ wide by 16½′ lonf in each of four replications. At the time of spraying air temperatures varied from 40 to 55° F., all soils were wet, and no weeds had yet emerged. Rainfall during the twelve days following spraying varied from none to 1.60″ and mean temperatures for the same period from 46° F. to 62° F. Weed control and onion injury ratings were recorded on May 23, (16 to 30 days after spraying), at which time the principal weed species present at all six locations was lambsquarters. No relationship was found between rainfall or mean temperatures during the twelve days following spraying and weed control or onion injury. CDAA at 4 lb gave good weed control at three locations but 6 lb was necessary for good control at a fourth location. The latter location had the lowest organic matter content (26%) and the highest pH (7.7) of the six soils. Monuron at 1.6 lb and CIPC at 8 lb gave moderately good weed control at five of the six locations. Monuron and CDAA behaved differently on the various soils as measured by weed control. On two of the soils monuron gave relatively poor weed control as compared to CDAA. These soils were moderately high in organic matter content (44 and 48%). Conversely, on two soils high in organic matter (65 and 70%), monuron gave somewhat better weed control than CDAA. The relationship between the herbicidal action of these two chemicals and the organic matter content of the soil, however, may be more apparent than real inasmuch as both gave good weed control on a mucky-marl soil relatively low in organic matter (26%). Onions were not injured by any herbicide except at one location where 1.6 lb monuron and both rates of CDAA caused slight injury. (Paper No.



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4014 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.)

**The tolerance of several vegetable and fruit crops to pre-planting treatments of dalapon on Plainfield sand. Rake, Leo, Groskopp, Myron, and Holm, LeRoy.** These experiments were conducted in 1957 and 1958 to determine the period of waiting which is required for the safe planting of some fruit and vegetable crops on sandy soils which have been treated with the sodium salt of dalapon. No effort was made to obtain a precise measurement of the period during which residual amounts of chemical remained in the soil. In 1958, the quack grass stand in the area was sparse and the fall-sown winter rye was 8 inches in height when dalapon treatments were made on May 7. Four strips 108 feet long and 35 feet wide were treated with 0, 4, 8, and 12 lb/A of dalapon. Untreated buffer areas were left between the strips. The area was plowed and fitted 12 days later. Sweet corn, cucumbers, snapbeans, lima beans, and potatoes were direct seeded, and tomatoes, peppers, strawberries, and raspberries were transplanted into the plots at 2, 3, and 4 weeks after chemical treatment. A single row of each crop was planted across the narrow dimension of each strip on each planting date. The treatments were not replicated and yields were not taken. One inch of water was applied by irrigation the day before plowing and on the days of the first and second plantings. In addition, 3.28 inches of rain fell during the period May 2 to July 1.

The crops growing in the areas treated with 4 and 8 lb/A of dalapon showed no injury. This was true at all of the planting dates. In the area treated with 12 lb/A of dalapon, the peppers, lima beans, and snapbeans which were planted two weeks after the chemical treatment showed slight injury from the dalapon. The characteristic puckering and rolling of leaves which is associated with dalapon injury was observed, but it was not serious and the plants quickly recovered and grew normally. The crops were not injured when planting was delayed until 3 and 4 weeks after the dalapon application. The remaining six crops showed no injury at this rate of treatment.

In 1957, an experiment which was very similar to the study described above was conducted in the same location. The rainfall during the period May 2 to July 1 amounted to 7.65 inches. No injury was observed on any of the crops during the entire season. It is believed that this excessive rainfall quickly leached the dalapon deep into the soil. (Department of Horticulture, University of Wisconsin Agricultural Experiment Stations, Hancock and Madison.)

**The use of NPA on cucumbers. Rake, Leo, Groskopp, Myron, and Holm, LeRoy.** Those who have worked with the sodium salt of NPA on any soil type are aware that its performance is variable when used as a pre-emergence treatment. In our experience this variability often seems to be associated with the pattern of rainfall and availability of soil moisture in the period following chemical application. During the course of experiments in which pre-planting, pre-emergence and post-emergence treatments of several chemicals were studied, it was discovered that pre-planting treatments of NPA were very effective. The treatments with NPA were as follows: **1. Pre-planting.** On May 28 the soil was fitted, 3 and 6 lb/A of NPA were sprayed on strips 40 feet long, the area was harrowed lightly and one-half inch of water was applied, Forty foot rows of Wisconsin SMR-12 cucumbers were planted in these blocks one week later. **2. Pre-emergence.** On June 4, forty foot rows of cucumbers were planted and immediately sprayed with 3 and 6 lb/A of NPA. One inch of water was applied immediately after planting. **3. Pre- and post-emergence.** On June 4, forty foot rows of cucumbers were planted and immediately sprayed with 3 and 6 lb/A of NPA. One inch of water was applied. On July 2, these same areas received 3 and 6 lb/A of NPA, respectively, as post-emergence treatment. **4. Post-emergence.** Cucumbers planted on June 4 were given a post-emergence spray of 3 and 6 lb/A of NPA on July 2. The soil was Plainfield sand. The rainfall from May 2 to July 15 amounted to 4.94 inches. The predominant weed in the area was lambsquarters. Smaller numbers of common ragweed and green foxtail were also present.

Treatment with 3 and 6 lb/A of NPA incorporated into the soil one week before planting provided about 95% weed control six weeks later. There was no injury to the cucumbers from this treatment. All other treatments caused light to moderate injury to the crop. Six pounds per acre of NPA applied either as a pre- or post-emergence treatment gave slight reduction in the number of weeds, but were ineffective for practical weed control. Twelve pounds per acre of the chemical applied to the same area, one-half as a pre-emergence and one-half as a post-emergence treatment, provided no effective weed control at any time during the season. (Department of Horticulture, University of Wisconsin, Agricultural Experiment Stations, Hancock and Madison.)

**Pre- and post-emergence weed control in cauliflower. S. K. Ries.** Snowball M cauliflower was direct seeded on a Wauseon sandy loam April 23, and the following treatments were applied immediately after planting: 4 and 8 lb/A CDEC, 4 lb/A CDAA, 10 lb/A HCA, 6 lb/A EPTC, and 5 lb/A dalapon. The soil was moist at time of application and 0.13 inches of rain occurred on April 24. Dalapon and the 8 lb/A rate of CDEC caused injury to the cauliflower. The best weed control without causing injury to the cauliflower was from the EPTC and CDAA treatments. For the post-emergence test, Snowball M was transplanted on July 23 and the following treatments were applied on August 4, after the plots were cleaned of weeds: 6 lb/A CDEC, both emulsifiable and granular, 6 lb/A EPTC, both emulsifiable and granular, 1 lb/A simazin 50% and 2 lb/A simazin as a granular, and 4 lb/A of granular neburon. One-half inch of water was applied with overhead irrigation immediately after application of the treatments. Plant injury resulted from the granular EPTC. Both forms of EPTC removed the "bloom" from the plants. Slight chlorosis occurred from both simazin applications. Excellent commercial weed control resulted from all treatments except neburon. (Department of Horticulture, Michigan State University.)

**Pre-emergence weed control in carrots. S. K. Ries.** The variety Gold Pak was planted on April 23 on a Wauseon sandy loam and the following treatments were applied immediately after planting: 4 and 8 lb/A of CDEC, and ½, 1, and 1½ lb/A of 2-chloro-4-diethylamino-6-isopropylamino-*s*-triazine (G-30031). Rain, 0.13 inches, fell on April 24. Commercial weed control resulted from the 1 and 1½ lb/A rates of G-30031. The only treatment which caused a reduction in yield was 8 lb/A of CDEC. The variety Red Cored Chantenay was seeded on June 17 on a Wauseon sandy loam and ½, 1, and 1½ lb/A of G-30031 applied on June 24. Excellent commercial weed control resulted from 1 and 1½ lb/A of G-30031. No injury resulted from the ½ or 1 lb/A rates of G-30031. (Department of Horticulture, Michigan State University.)

**Green foxtail control in potatoes, 1958. Selleck, G. W.** TCA and dalapon at 20 lb/A, TCA and dalapon at 20 lb/A plus 3 lb/A DNBP and simazin at 8 lb/A were applied to green foxtail in potatoes with a logarithmic sprayer to duplicated, 15 x 135 ft plots on sandy loam soil near Saskatoon July 4, 1958. The above herbicides were applied to variety Columbia Russet while dalapon at a 20 lb initial rate was applied also to varieties Netted Gem and Early Waseca. The potatoes were 4 to 10 in high with 7 leaves and about 50% of them were budding. The green foxtail was in various stages from one to four leaves and from ½ to 8 in tall. The minimum rates (lb/A) which provided satisfactory control of green foxtail, damaged tops and permitted normal yield of Columbia Russet potatoes, are provided in the following table.



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| Herbicide | Minimum rate, lb/A, giving: Satisfactory control of green foxtail | Potato tops: Damage | Potato tops: Discoloration | Normal potato yield |
|---|---|---|---|---|
| TCA | 3.6 | — | 5.0 | 20.0 |
| Dalapon | 1.2 | — | 3.2 | 4.2 |
| Dalapon + DNBP | 1.5 + 0.3 | 10.0 + 1.6 | 1.6 + 0.2 | 3.6 + 0.5 |
| TCA + DNBP | 2.4 + 0.4 | 2.4 + 0.4 | 1.5 + 0.2 | 3.2 + 0.5 |

Dalapon appeared to produce knobbiness in varieties Netted Gem and Early Waseca at rates in excess of 3 lb/A, and changed skin color of Early Waseca from red to that resembling a Russetted potato even at the lightest rate (0.4 lb/A). Dalapon-DNBP and TCA-DNBP mixtures controlled redroot pigweed and lambsquarters at rates similar to those which caused abnormalities to tubers. Sodium arsenite top killer, which was applied to the three varieties Sept. 3 at an initial rate of 16 lb/A, gave good top kill at the 5 lb/A rate. (Contribution from the Department of Plant Ecology, University of Sasketchewan, with financial assistance from the Sasketchewan Agricultural Research Foundation.)

## FLOWERS

**Effects of neburon on garden flowers. Corns, Wm. G.** Single rows 16 sq ft in area were sprayed in July at flowering stage with rates of neburon shown in the following summary. The observations were recorded from mid-August to September.

| *Species* | *Comments* |
|---|---|
| Ageratum (Blue Perfection): | No damage from 4 or 5 lb/A in 50 gal water. |
| Alyssum (White Carpet): | Severe damage from 4 or 5 lb/A. |
| Aster (Powder Puff): | No damage from 4 or 5 lb/A. |
| Delphinium: | No damage from 2, 4 or 8 lb/A. |
| Lilies: | No damage from 2, 4 or 8 lb/A. |
| Marigold: | No damage from 4 or 5 lb/A. |
| Nemisia (Nana Compacta): | No damage from 4 or 5 lb/A. |
| (Five King): | No damage from 4 or 5 lb/A. |
| Pansy (Swiss Giants): | Plants slightly retarded by 4 or 5 lb/A. |
| Phlox (Globe Mixed): | Severe damage from 4 or 5 lb/A. |
| Salpiglossis: | Plants retarded by 4 or 5 lb/A; fewer flowers than checks. |
| Zinnia (Double giants): | Some chlorosis from 4 or 5 lb/A. |

Further trials including directional spraying appear to be warranted. (Division of Crop Ecology, Department of Plant Science, University Alberta.)

## ORNAMENTAL AND FOREST NURSERIES

**Pre-emergence weed control in tobacco with herbicides applied near time of transplanting*. Freeman, J. F.** Burley tobacco (Ky. 16 variety) was transplanted on Maury silt loam soil June 21, 1958. A tractor mounted transplanter was used to set the plants 18" apart in 42" rows. Herbicides were applied in 25 gal/A water, 1 day before or 2 days after transplanting. Treatments were CDAA, 4 lb/A *before;* CDAA, 4 lb/A *after;* CDAA-S (solventless), 4 lb/A *before;* CDAA-S, 4 lb/A *after;* 2-chloro-4-ethylanmino diethylamino-*s*-triazine (G-27901), 2 and 4 lb/A *before* G-27901, 2 and 4 lb/A *after;* EPTC, 2 and 4 lb/A *before;* EPTC, 3 lb/A *after;* and no treatment. Good soil moisture conditions prevailed at time of transplanting and good rains fell the 3d day after final treatments. Weeds emerged rapidly where treatments did not prevent, with crabgrass and pigweed predominating. Treatments were in a randomized block design with 4 replications. Four weeks after transplanting the number of weeds of each treatment was determined in a 14" band centered over the 2 inner rows of the 4-row plots. G-27901, 4 lb rate *before* transplanting resulted in 91% control of weeds, the number on untreated check being 23.7/sq ft (10.4 grasses + 13.3 broadleaf weeds). The growth of the tobacco was not affected appreciably by the treatment. G27901, 4 lb rate *after* gave better weed control (96%) but the tobacco was retarded in growth, the height at harvest time being about 6" less. G-27901 at 2 lb rate *before* gave 68% control of weeds and *after* 79% control. EPTC, 3 lb *after* gave 56% control of weeds and did not harm the tobacco. Used at the 2 and 4 lb rates *before* gave poor weed control, which probably would have been improved by incorporating it with the soil. CDAA or CDAA-S gave neglible control *before* and slightly less than 50% control *after*. Quality and smoking tests are to be made of leaf samples of the various treatments. (Agronomy Department, Kentucky Agricultural Experiment Station.)

**Control of weeds in transplant bed paths. Mahlstede, J. P.** This experiment was designed to screen various weed control chemicals for possible use in walks between lining-out beds containing nursery stock and between display bins in nursery sales yards. Six-foot-wide alternating beds of soybeans and oats were drilled on May 17th, 1958. A three foot path separated each bed. Replicated, 100 square foot plots were then laid out in these paths and treated on June 20 with the following chemicals: DMTT (300 lb/A), CIPC 5% granular (160 lb/A), SMDC (1 qt/100 sq ft), CDAA (4 lb/A), simazin (3 lb/A), amitrol (1 lb/A), EPTC (6 lb/A), diuron (2 lb/A), monuron (2 lb/A), and NPA (5 lb/A). Each plot was hand weeded immediately prior to herbicide application. Weed control effectiveness was determined 55 days after herbicide application and was based on weed counts and density stand estimates. Lateral translocation as determined by soybean and oat plant growth in successive rows away from the area of application was evaluated at two week intervals during the course of the experiment. None of the chemicals used in this experiment caused injury to either the soybeans or oats, regardless of their proximity to the treated area. CDAA gave 100% control of grasses within the test plots, but poor control of broadleaf weeds. Satisfactory weed control over the 55 day observation period was obtained through the use of diuron (91%), and CIPC (89%). The remaining chemicals gave varying degrees of weed control, but were considered unsatisfactory under the conditions which prevailed during this experiment and for the use intended. (Department of Horticulture, Iowa Agricultural Experiment Station.)

**Use of sesone and CDAA for the control of weeds in container grown nursery stock. Mahlstede, J. P. and Fletcher, W. E.** Replicated one gallon containers of *Forsythia intermedia spectabilis* and *Malus hopa* grown in a mixture of peat and sand for two years were used in this experiment. CDAA (8 lb/A), sesone (8 lb/A), and a mixture of CDAA (8 lb/A) and sesone (8 lb/A) were applied on August 14, 1958 in 250 ml. of water to the surface of each container, previously seeded with 15 wheat and 10 bush lima bean seeds. Readings on percent germination, height of weed seedlings and general appearance of the weeds and plant material were taken at weekly intervals. Application of CDAA at the rate of 8 lb/A gave 100% control of wheat throughout the four week observation period. The germination of the lima beans was inhibited during the first two weeks, although by the end of the third week only 50 percent control was recorded. There were no visible signs of injury to either ornamental during the course of the test. Sesone (8 lb/A) gave 100% control of emergence of beans at the end of the first week, 94% control at the end of the second week, and 80% control by the end of the third week. Control of wheat germination ranged from 45% at the



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end of the first week to 25% by the third week. There were no visible signs of injury to either ornamental. A combination of CDAA and sesone gave 100% control of the wheat and beans through the third week, without causing noticeable injury to either the forsythia or crabapple. (Department of Horticulture, Iowa Agricultural Experiment Station.)

**Weed control in container grown nursery stock. Mahlstede, J. P. and Fletcher, W. E.** Plants of *Lonicera tatarica rubra, and Cercis canadensis* were grown for a period of two years in each of three media: equal volumes of sand and peat (pH 7.2), peat and perlite (pH 7.7), and sphagnum moss and perlite (pH 6.7). Fifteen seeds of Henderson's Bush lima bean, and an equal number of wheat seeds of the variety Pawnee were sown in each one gallon container on August 6, 1958. One half of the replicated experiment was fertilized with uramite immediately prior to herbicide application. Simazin (3 lb/A), amitrol (1 lb/A), monuron (2 lb/A), CDAA (5 lb/A), and a combination of sesone (5 lb/A) and dalapon (5 lb/A) were applied in 250 ml. of water to the surface of each container. Percent germination and height of the bean and wheat seedlings, in addition to observations on the performance of the ornamentals were recorded at weekly intervals for a period of five weeks. There was normal germination and growth of beans and wheat in containers treated with simazin (3 lb/A) until the 9th day. At this time marginal burning of the primary leaves of bean became apparent, and by the 15th day all foliage was burned-off, although adventitious shoots were beginning to form. One hundred percent control of both the bean and wheat was recorded by the end of the 4th week. Foliage of the redbud was mottled and chorotic and this was accompanied by severe leaf burn at the distal portions of the honeysuckle canes. Fertilization modified the severity of the leaf symptoms. Although slower acting than simazin, monuron gave similar control and symptoms regardless of the growing medium. The weed control obtained from amitrol was unsatisfactory under the conditions of this experiment. Application of CDAA (5 lb/A) gave 33 percent control of beans and 95 percent control of the wheat by the end of the 4th week. Leaf chlorosis in both ornamentals was minimized by the application of fertilizer in containers treated with CDAA and a combination of sesone and dalapon. The more acid the growing medium, the greater the initial germination inhibition of beans and wheat in containers treated with sesone and dalapon. Under the heavy watering schedule, weed control was unsatisfactory by the end of the second week, regardless of the growing medium. (Department of Horticulture, Iowa Agricultural Experiment Station.)

**Weed control in coniferous nursery stock. Taylorson, Ray and Holm, LeRoy.** Three beds, each 4 feet wide, were planted with six species of two year old graded nursery stock. Each bed contained a single row of each of the following species: Douglas fir, Scotch pine, Austrian pine, white spruce, blue spruce, and Multiflora rose. The soil was a sandy loam. The predominant weed species in the area were: lambsquarters, crabgrass, foxtail, and quackgrass. Several crucifer species occurred in smaller numbers. Herbicides were applied in the first week of May to plots 10 feet by 4 feet in size. There were no visible signs of growth of the nursery stock at this time. The treatments are given below in pounds per acre and are followed by the weed control results in mid-July. The data are expressed as percentage of weed stand reduction in comparison with unweeded checks.

Simazin at 1, 2, and 4 gave 89, 92 and 94%; diuron ½ and 1 gave 77 and 92%; dalapon at 5 and EPTC at 5 and 10 provided 60% or less weed control. Mixtures of simazin at 1 with either dalapon or EPTC at 5 gave 95% control. Mixtures of diuron at ½ with either sesone 4, dalapon 5, simazin 1, or EPTC 5 gave 90% control. EPTC at 5 mixed with dalapon at 5 gave 93% control. Superior weed control was maintained through September with the higher rates of simazin and with the simazin plus dalapon mixture.

Growth measurements were taken in early fall. Multiflora rose was slightly stunted where dalapon was used but was uninjured by other treatments. There was no injury to the coniferous species from any treatment. However, it is known that conifers are quite sensitive to most herbicides when treated after new growth starts. (Department of Horticulture, University of Wisconsin, Agricultural Experiment Station.)

**2-Chloro-4-ethylamino-6-diethylamino-s-triazine (Trietazine) for field weed control in tobacco. Tibbitts, T. W.** Tobacco plants, variety Havana 425, were spaced 22" apart in 36" rows for trials conducted in 1957 and 1958 on silt loam soil. All treatments were applied with a knapsack sprayer at a pressure of 30 psi in 30 gpa of water. In 1957 treatments of 2 and 4 lb/A of Trietazine just before, immediately after, and 2 weeks after transplanting, effectively controlled all weeds. The weed stand was predominantly pigweed and purslane. In 1958 weed control was not complete. Purslane was effectively controlled but only about one-half of the pigweed was eliminated and no control of annual grasses (*Setaria lutescens* and *Echinolchloa crusgalli*) was obtained. Four pounds of the material gave better weed control than 2 pounds. In 1957, 4" of rain fell in the 4 weeks following transplanting with heaviest rains of 1.9" and 0.9". In 1958, 1.5" fell in the 4 weeks following transplanting with heaviest rains of 0.5" and 0.4". The pre-transplanting treatments in 1957 produced no symptoms of injury to the growing plants or reduction in yield and quality of the harvested tobacco. A slight mottled chlorosis was evident in 1958. This may have resulted because many of the plants were not set properly and this permitted the treated surface soil to be brought in direct contact with the roots. All post-transplanting applications produced a mottled chlorosis on the larger leaves about 5 days after treatment. Stunting developed and the yield was significantly reduced. (Department of Horticulture, Wisconsin Agricultural Experiment Station.) (Supported in part by the Tobacco Industry and Cooperatives.)

## CONTROL OF WOODY PLANTS FORESTS AND SHELTERBELTS

**AMS, 2,4,5-T, and mechanical girdling of black oak. Irving, F. D.** The following treatments were applied to black oaks from 2-30 inches in diameter in July and October of 1956: (1) AMS (Ammate) crystals in axe cut notches; (2) basal spray of the propylene glycol butyl ether ester of 2,4,5-T in fuel oil (16 pounds ahg); (3) mechanical girdle by gas powered, flexible shaft cutting tool. Top kill with all treatments was greater than the control. Both summer and fall girdling produced basal sprouts, but no sprouting was observed on chemically treated trees. Top kill after two years was almost complete on girdled trees. The July basal spray of 2,4,5-T gave 93% top kill after two years. The dormant season basal spray kill was less than 50%. A heavy rain immediately after the July treatment flushed some AMS crystals out of the notches and probably reduced its effectiveness. Girdling is recommended only if sprouts are desired or not considered objectionable. Basal spray should be both efficient and effective for cull treatment jobs involving large numbers of trees. Ammate in notches is satisfactory as a summer treatment, and should be best for jobs involving only a few trees. (School of Forestry, University of Minnesota.)

**Chemical control of crested wheat grass growing under ash trees. McCurdy, E. V.** TCA at 20, 40, 60, 80, and 100 lb/A was applied in 1957 to a series of plots of crested wheat grass growing under ash trees. Notes in 1958 indicated that rates above 40 pounds, high enough



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to control grass, injured the trees, and at 80 and 100 lb/A killed the trees. Dalapon was applied at 15 and 20 lb/A in 1957. Grass was controlled and the trees were showing no injury this year. The same rates were repeated on new plots in 1958, with excellent control of grass resulting but at the 15 lb/A rate the trees were injured and at the 20 lb/A rate completely defoliated. Amitrol was applied at 4, 9, and 12 lb/A. At the 4 lb/A rate grass was not killed and the trees were normal, at 8 lb/A grass was severely retarded and the trees remained normal and at the 12 lb/A rate the grass was killed but one tree showed slight discoloration of the leaves in the early fall. A mixture of dalapon and silvex (Zytron) at 7 gal/A (14 lb/A dalapon and 3½ lb/A silvex), applied in the late summer, controlled the grass but injured the trees. TCA applied at 40 lb/A in 1957 on grass growing under spruce killed the trees. Dalapon applied at 20 lb/A this year resulted in no injury whatever to the spruce to date. (Contributed by the Experimental Farm, Indian Head, Saskatchewan.)

## BRUSH ON RANGELANDS AND PASTURES

**Chemical analyses of four grasses from areas treated with 2,4,5-T and silvex. Elwell, Harry M. and Webster, James E.** Samples of big and little bluestem, Indian and switch grasses were taken on Aug. 5 and Oct. 7, 1957 from areas treated with 2,4,5-T, silvex and from an adjacent untreated area. The propylene glycol butyl ether ester of each herbicide had been aerially applied at 1.8 lb/A on May 28, 1957. The grasses from all areas had made a good foliage growth on first date sampled and were producing seed when sampled on the last date. All analyses were made in accordance with standard procedures. The chemical data showed some inconsistencies; however the over-all trends indicated the following: (1) the total sugars for all grasses for area treated with 2,4,5-T was approximately the same as for untreated for Aug. sampling date; however, there was a 13 percent increase for treated over untreated for Oct. sampling; (2) the silvex treated grasses had a higher total sugar content than the untreated check, 34 and 12 percent respectively for first and second sampling dates; (3) acid hydrolysis values (A.O.A.C. method for starch) and total nitrogen were approximately the same for all grasses from treated and untreated plots for both sampling dates; (4) however, the 80 percent alcohol soluble solids for Aug. date were less for treated than for untreated, 4 percent for 2,4,5-T and 5 percent for silvex. The soluble solids for the Oct. sampling were higher for treated than for untreated, 4 percent for 2,4,5-T and 7 percent for silvex. Production of grass treated with 2,4,5-T was four times as large as the untreated; and silvex three times as large. (Contribution from Agronomy and Biochemistry Departments, Oklahoma Agricultural Experiment Station and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, cooperating. Approved as Journal Manuscript No. 452.)

**Chemical analyses of twigs from oaks sprayed with 2,4,5-T and silvex. Elwell, Harry M. and Webster, James E.** Twig samples were taken from small, medium and large post and blackjack oaks seventy days after treatment with 2,4,5-T and silvex. The propylene glycol butyl ether ester of each herbicide was aerially applied at 1.8 pounds of acid per acre on May 28, 1957. The plants when treated were in full leaf and growing very rapidly due to above normal rainfall and favorable temperature conditions. Samples were taken from five marked plants for each of three sizes in the treated and adjacent untreated areas. All analyses were made in accordance with standard procedures. The data for various size twigs and species of oak were somewhat inconsistent; however, the over-all trends indicate the following: (1) a reduction in total sugars for treated over untreated, 73 percent for 2,4,5-T and 75 percent for silvex; (2) a reduced difference for acid hydrolysis for treated over untreated, 3 percent for 2,4,5-T and 6 percent for silvex; (3) however, there was an increase in total nitrogen for treated over untreated, 35 percent for 2,4,5-T and 37 percent for silvex; (4) the 80 percent alcohol soluble solids were 23 percent less for 2,4,5-T and 26 percent less for silvex than for the untreated. (Contribution from Agronomy and Biochemistry Departments, Oklahoma Agricultural Experiment Station and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, cooperating. Approved as Journal Manuscript No. 453.)

**Control of persimmon with 2,3,6-TBA and 2,4,5-T. Peters, E. J.; Kerr, H. D.; Davis, F. S.; and Klingman, D. L.** A dense stand of persimmon, ranging from ¼" to 4" in diameter, was treated with 2,3,6-TBA and 2,4,5-T using various rates, formulations, and methods of application. Treatments listed in the table below were applied August 14 and 15, 1956, and were replicated three times. Estimates of percentage defoliation and counts of resprouting trees as measures of plant kill were made August 19, 1958.

| Treatment, formulation, and method of application | Rate lb/ahg | Pct defoliation 1958 | Pct of trees resprouting 1958 |
|---|---|---|---|
| **Water carrier** | | | |
| 2,3,6-TBA, sodium salt[1], sprayed on foliage | 2 | 90 | 0 |
| | 4 | 100 | 0 |
| 2,4,5-T, Amine[2], sprayed on foliage | 2 | 31 | 32 |
| | 4 | 50 | 30 |
| 2,3,6-TBA, Sodium salt[1], sprayed on entire ground surface | 8 | 92 | 3 |
| | 16 | 100 | 0 |
| 2,3,6-TBA, Sodium salt[1], wet soil around base of each tree and outward 2 feet | 8 | 94 | 8 |
| | 16 | 100 | 1 |
| **Oil carrier** | | | |
| 2,4,5-T, isooctyl ester[3], basal treatment | 16 | 86 | 9 |
| 2,3,6-TBA, sodium salt[4], basal treatment | 8 | 35 | 65 |
| | 16 | 73 | 24 |
| Check | .... | 40 | 25 |

[1] DuPont. [3] Pittsburg Chemical Company.
[2] Rohm and Haas. [4] Heyden Chemical corporation.

A foliage treatment with 2,3,6-TBA applied at 4 lb ahg water resulted in 100 percent defoliation and no resprouting after two years. When applied at 16 lb ahg water to the entire soil surface or in a two foot circle around the base of the trees, 2,3,6-TBA resulted in 100 percent defoliation with negligible resprouting. Lower rates of 2 lb ahg for the foliage treatment and 8 lb ahg water for the soil surface treatment were slightly less effective. Foliage treatment with 2,4,5-T at 2 and 4 lb ahg water was unsatisfactory. The 2,3,6-TBA and 2,4,5-T applied as basal treatments in oil were also unsatisfactory. High defoliation in check plots occurred adjacent to plots treated with TBA and may have been the result of spray drift or movement of the chemical in or on the surface of the soil from treated plots to the check plots. (Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Missouri Agricultural Experiment Station, cooperating.)

## BRUSH ON RIGHTS-OF-WAY

**Liquid amitrol formulation on poison ivy. Melander, L. W. and K. L. Blanchard.** The dry formulations of amitrol are effective killers of poison ivy. On June 5, 1958 a liquid formulation of amitrol (ACP-M-569) was applied in water solutions at concentrations of 2, 1 and ½ pound ahg, along with solutions of dry amitrol at 2 and 1 pound ahg, to plots containing a heavy stand of poison ivy in Washington County, Minnesota. On August 15, 1958, the plots were evaluated as to the amount of top kill effected as 100, 99 plus, 99 plus, 95 and 99 percent respectively. (Plots in other areas in the state also were treated with concentrations of 2 and 1 pounds ahg of liquid amitrol with similar results.) On October 10, 1958, the rhizomes in the plots treated with the 2 pound ahg concentrations (both liquid and dry) were dead and shrivelled. Those treated with 1 pound ahg (both liquid and dry) and ½ pound ahg (liquid only) were not shrivelled but the cambium of these rhizomes was discolored and from their appearance, there is some doubt that the buds are still viable. It is concluded that the liquid formulation is at least equally as effective as the dry formulation of amitrol for killing poison ivy. (Contribution of Amchem Products, Inc., Ambler, Pa. and the Minnesota Department of Agriculture.)

## CHEMICAL DRYING AND PREHARVEST WEED CONTROL

**An evaluation of magnesium chlorate as a pre-harvest desiccant for grain sorghum. Phillips, W. M.** Aerial applications of magnesium chlorate at 5 and 7½ lb/A were made September 25, 1957 to one hybrid and one variety of grain sorghum. All were made in a total volume of 5 gallons per acre of a water solution. Weather conditions from September 25 to October 6 were warm and dry; thus there was rapid drying of both the treated and the untreated sorghum grain. Beginning October 7, damp, cloudy weather prevailed for more than 2 weeks, and comparatively little drying occurred during that period. DeKalb D-50 hybrid sorghum, a loose-headed type, had 33% moisture in the grain at the time of treatment. Three days after treatment it was evident that excellent coverage had been obtained. Most of the sorghum leaves began to turn brown, and it appeared that moisture content of the leafy parts of the plant was being reduced rapidly. Grain for moisture determinations was obtained by hand sampling on September 28, September 30 and October 3. In addition, samples were taken from a combine on October 3 and October 28. At no time was there more than 0.5 percent difference in grain moisture between the untreated check and the plots treated with 7½ lb/A magnesium chlorate. The only apparent advantage due to treatment was that less green plant material was present at the time of combining. This enabled the machine to move at a higher speed but otherwise did not improve the threshing efficiency. Similar results were obtained on Midland, a compact-head variety. At no time following treatment was there a significant difference in moisture content between the treated and untreated grain. (Contributed by the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Fort Hays Branch of the Kansas Agricultural Experiment Station, Hays, Kansas cooperating.)

## AQUATIC WEED CONTROL

**Aerial application of amitrol to cattails in east-central Minnesota. Jones, Bernard R.** Amitrol was applied to two 1.4 acre plots in the Carlos Avery Game Refuge at rates of 3.4 and 6.6 lb/A. Cattails in each plot were standing in water approximately 3 to 6 inches deep. Applications were made on September 4, 1957 when cattails were at the mature pre-dormant stage. Spray drift was negligable. During the fall of 1957 effects of the applications were but slightly distinguishable from natural die-down. Regrowth in the 1958 season was sparse with substantial portions of the plots containing no cattails. Stem counts in October 1958 indicated approximately 97% reduction in cattails in the plot treated at 3.4 lb/A and 98% reduction in cattails in the plot treated at 6.6 lb/A. Sedge *(Carex riparia)* appeared significantly affected at the 6.6 lb/A rate. Density of sedge in 1958 in the plot treated at the 6.6 lb/A rate was estimated to be 50% lower and individual plants appeared less robust than in untreated areas. Mortality of *Phragmites* in the area treated at 6.6 lb/A was nearly complete with only very sparse regrowth evident in October 1958. (Minnesota Department of Conservation, St. Paul. Acknowledgement is gratefully made to Dr. L. W. Melander, Amchem Products Inc., for assistance.)

## BASIC STUDIES IN BOTANY, ECOLOGY AND PLANT PHYSIOLOGY

**The effect of alternate wet-and-dry treatments on germination and dormancy of wild oats. Kommedahl, Thor.** Wild oats grains were soaked for 3-hour periods in either running tap water or in standing tap water, then dried for about 20 hours in a forced-air drier and tested for germination. Certain comparisons were made with 1, 2, and 3 successive wet-dry treatments; in running and standing tap water; in 50, 100, 150, and 200 ml of water; at water temperatures of 18 and 24° C; and with hulls on or off. Tests for germination were made in Petri plates, using 400 grains per treatment, at 20-25° C. Alternate wetting and drying reduced germination of wild oat grains from 96% (control) to 91% when soaked in running water and to 29% when soaked in standing water, after one wet-dry treatment. After three successive wet-dry treatments, germination decreased to only 86% when grains were wet with running water but decreased to 13% in standing water. After grains were stored dry for 1 month following three wet-dry treatments using standing water, the germination rose to 50%, indicating that a secondary dormancy had been induced. Similar results obtained with other trials. When grains were dehulled, there was no appreciable difference in germination percentage when soaked in standing or in running water, nor was secondary dormancy induced by wet-dry treatments. Volume of water apparently is a factor as percentage germination was higher when 200 grains were soaked in 200 ml of water than when 200 grains were soaked in 50 ml of water. Intermediate volumes gave intermediate results. Percentage germination was higher when grains were soaked in water at 18° C than when soaked in water at 24° C, whether the volume of water was 50 or 200 ml. (Contribution of Department of Plant Pathology and Botany, Institute of Agriculture, University of Minnesota, St. Paul. Paper No. 4012, Scientific Journal Series, Minnesota Agricultural Experiment Station.)

**The ecological effect of a preceding crop on smartweed in flax. Kommedahl, T.** At Rosemount, Minnesota, smartweed was studied in plantings of flax that followed corn, oats, wheat, flax, or soybeans. MCPA at 4 oz/A and TCA at 5 lb/A were sprayed on these plots shortly after emergence of flax. At maturity, plants were harvested from 5 sq ft from each of 4 replicates. The number of smartweed plants per unit area, the height of plants, percentage of smartweed plants in the total plant population, and oven-dry weights per plant were taken. Smartweed plants com-



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prised the highest percentage of the total plant population (crop plus weeds) in flax after soybeans or flax, and lowest after corn, oats and wheat. There were 70 smartweed plants per sq yd in flax after soybeans, 63 after flax, 22 after corn and wheat, and 16 after oats. Smartweed plants averaged at least 10 cm taller after soybeans or flax than after corn, oats, or wheat. Dry weight per smartweed plant was highest after flax (1111 mg), and less after other crops in the following order: soybeans (814 mg), corn (671 mg), oats (594 mg) and wheat (429 mg). Thus smartweed plants in flax after flax were tallest and largest while those after wheat were shortest and smallest. In general, data for smartweed plants in flax after flax and soybeans were similar, and substantially higher values were obtained than for plants in flax after corn, oats, or wheat. (Department of Plant Pathology and Botany, University of Minnesota, St. Paul. Paper No. 4016, Scientific Journal Series, Minnesota Agricultural Experiment Station.)

**Effects of water extracts of quackgrass rhizomes on damping-off and dry weight of alfalfa seedlings. Kommedahl, T. and Ohman, J. H.** Ranger alfalfa was grown in the greenhouse in pots containing autoclaved and nonautoclaved soil. Half of the pots were watered with an extract made from dried quackgrass rhizomes. Two-hundred grams of dried rhizomes ground to a 40-mesh size were added to 1 L of distilled water, autoclaved for 20 minutes, allowed to steep for 24 hours, filtered, and the residue resuspended and again treated in the same way. Then sterile distilled water was added to the second leachate to give a final volume of 10 L (2 per cent solution). Checks were watered with tap water. The experiment was concluded 5 weeks after sowing when the original 10 L of extract was expended. Checks and treatments received equal amounts of liquid each time they were watered. In autoclaved soil watered with the extract, emergence was about the same, average dry weight per plant was 7.7 mg less, and final stand was only slightly less than on soil watered with tap water. In nonautoclaved soil watered with the extract, the average dry weight per plant was 8.3 mg less, and final stand slightly less than in pots watered with tap water. Also the combination of extract and nonautoclaved soil resulted in about half the plant dry weight compared to results from adding extract to autoclaved soil. Both pre-emergence and post-emergence damping off was substantially greater in nonautoclaved soil receiving the extract than in either nonautoclaved soil alone or in autoclaved soil with or without extract. Thus extracts of quackgrass apparently retard growth of alfalfa directly and also by favoring disease development of seedlings. (Contribution of Department of Plant Pathology and Botany, Institute of Agriculture, University of Minnesota, St. Paul. Paper No. 4010, Scientific Journal Series, Minnesota Agricultural Experiment Station. Supported in part by the Rockefeller Foundation.)

**Observations in 1958 on plots treated with simazin and monuron in 1957. Switzer, Clayton M.** Treatments with simazin at 1, 2, and 3 lb/A and monuron at 1, 2, and 4 lb/A were included in an experiment set up in June, 1957 to study the persistence of several herbicides in soil (Res. Rept. NCWCC 165-166, 1957). Additional triplicated plots were treated in the same manner in September, 1957. Effects on weed growth were noted in April, July and September, 1958. Also seeds of oat, turnip and sugar beet, and seedlings of tomato, were planted in July as indicator crops. In April, 1958, all plots treated with monuron at 4 lb/A or with simazin at 2 and 3 lb/A in June, 1957, were bare of vegetation. Weed stands in the monuron plots at 1 and 2 lb/A and the simazin plots at 1 lb/A were about 50% of control. By July, however, only the simazin plots at 3 lb/A showed any effects on either weed population or indicator plants. The oats in these plots became chlorotic soon after emergence but most plants recovered.

All of the simazin plots treated at 1, 2, and 3 lb/A in September, 1957, remained bare of weeds throughout the summer of 1958. Turnips and tomatoes planted in late July in the 1 lb/A simazin plots survived; oats and sugar beets were 80-90% killed. All indicator crops were killed in the 2 and 3 lb/A simazin plots.

A few (10% of control) weeds were present in April in the monuron plots treated at 1 lb/A in September, 1957, but the monuron plots at 2 and 4 lb/A were bare. By July the monuron plots at 1 lb/A had weed cover equal to the checks. The monuron plots at 2 and 4 lb/A remained bare throughout most of the summer but by September weeds were beginning to grow in the 2 lb/A monuron plots. In the treatment with monuron at 4 lb/A, oats, turnips, and tomatoes were killed but the sugar beets survived and appeared normal in September. (Department of Botany, Ontario Agricultural College, Guelph.)

**The differential susceptibility of wild carrot plants to various herbicides. Whitehead, C. W. and Switzer, C. M.** Strains of wild carrot which differ in their response to 2,4-D have been shown to exist. A susceptible strain is killed by concentrations of this herbicide that have little effect on the resistant strains. All plants show similar injury responses for a few days after treatment, but the resistant types recover within a short time. This difference also exists after treatment with 4-MCPB and 4-2,4-DB but not with 2,4,5-T, silvex or 2,4-D—2,4,5-T mixture.

No differences were found in the effects of 2,4-D on the germination of seeds from susceptible and resistant plants. Elongation of radicles in the presence of 2,4-D was also similar. However, pre-emergence treatment of soil with this herbicide resulted in a marked reduction in the emergence of susceptible wild carrot seedlings in relation to resistant ones.

The possibility was considered that this differential response might be related to differences in absorption and/or translocation of herbicide from treated leaves. However, since similar responses were obtained when the chemicals were applied through the soil, a probable difference in the metabolism of the two strains is indicated. This difference appears to arise between the time the seed germinates and the cotyledons expand. Respiration studies in which 2,4-D has been applied to various tissues of the wild carrot plant in Warburg flasks have failed to show differences. The possibilities remain that either rapid catabolism of certain herbicides is carried out by the resistant plants, or that they are adsorbed in these plants on certain proteinaceous materials to a greater extent than in the susceptible strain. Either mechanism would lead to the reduction of active 2,4-D in the resistant plants and hence explain their recovery. (Department of Botany, Ontario Agricultural College, Guelph, Ontario.)



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# REGISTRATION LIST

## NORTH CENTRAL WEED CONTROL CONFERENCE

### Cincinnati, Ohio

### December 3, 4, 1958

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## LIST OF MEMBER COMMERCIAL ORGANIZATIONS

### As of December 31, 1958

| | |
|---|---|
| Allied Chemical Corporation | Edgewater, New Jersey |
| Amchem Products, Inc. | Ambler, Pennsylvania |
| American Cyanamid Company | New York, New York |
| Atlas Powder Company | Wilmington, Delaware |
| Brown Farm Chemical Company | Scottsbluff, Nebraska |
| Burg Manufacturing Company | Waverly, Nebraska |
| California Packing Corporation | Rochelle, Illinois |
| Chemagro Corporation | New York, New York |
| Chipman Chemical Company, Inc. | Bound Brook, New Jersey |
| Chipman Chemicals Limited | Winnipeg, Manitoba, Canada |
| Clark Manufacturing Company | Atherton, Missouri |
| Columbia-Southern Chemical Corporation | Pittsburgh, Pennsylvania |
| Davey Tree Expert Company | Kent, Ohio |
| Deere & Company | Moline, Illinois |
| Delavan Manufacturing Company | West Des Moines, Iowa |
| Diamond Alkali Company | Cleveland, Ohio |
| Dow Chemical Company | Midland, Michigan |
| E. I. du Pont de Nemours & Company | Wilmington, Delaware |
| Fargo Foundry Company | Fargo, North Dakota |
| Farmers Union Central Exchange | St. Paul, Minnesota |
| Farmrite Sprayer, Inc. | Juneau, Wisconsin |
| F. H. Peavey & Company | Minneapolis, Minnesota |
| Food Machinery & Chemical Corporation | Lansing, Michigan |
| Food Machinery & Chemical Corporation | Middleport, New York |
| Geigy Agricultural Chemicals | Yonkers, New York |
| Hahn, Inc. | Evansville, Indiana |
| Hart Equipment Company | Rockton, Illinois |
| Heyden Newport Chemical Corporation | New York, New York |
| Hooker Electrochemical Company | Niagara Falls, New York |
| Hypro Engineering, Inc. | Minneapolis, Minnesota |
| Illinois Farm Supply Company | Chicago, Illinois |
| Miller Chemical Company | Omaha, Nebraska |
| Monsanto Chemical Company | St. Louis, Missouri |
| Mutual Dealers Wholesale, Inc. | St. Paul, Minnesota |
| National Aluminate Corporation | Chicago, Illinois |
| National Grain Company Limited | Winnipeg, Canada |
| Naugatuck Chemical | Bethany, Connecticut |
| Naugatuck Chemical | Chicago, Illinois |
| Oberdorfer Foundries, Inc. | Syracuse, New York |
| Pennsalt Chemicals Corporation | Aurora, Illinois |
| Private Brands, Inc. | Kansas City, Kansas |
| Reade Manufacturing Company, Inc. | Jersey City, New Jersey |
| Reasor-Hill Corporation | Chicago, Illinois |
| Riverdale Chemical Company | Chicago Heights, Illinois |
| Sherwin-Williams Company | Montreal, Quebec, Canada |
| Spraying Systems Company | Bellwood, Illinois |
| Standard Agricultural Chemicals, Inc. | Hoboken, New Jersey |
| Standard Oil Company (Indiana) | Chicago, Illinois |
| Stauffer Chemical Company | Omaha, Nebraska |
| Swift & Company | Chicago, Illinois |
| Thompson-Hayward Chemical Company | Kansas City, Missouri |
| Thomson Chemicals Corporation | St. Louis, Missouri |
| Tri-State Milling Company | Rapid City, South Dakota |
| Tryco Manufacturing Company, Inc. | Decatur, Illinois |
| U. S. Borax & Chemical Corporation | Los Angeles, California |
| Union Carbide Chemicals Company | New York, New York |
| W. H. Barber Company | Minneapolis, Minnesota |
| Woodbury Chemical Company | St. Joseph, Missouri |



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| Peach | *Prunus persica* | 70 |
| Peas | *Pisum sativum* | 7, 11, 63, 98, 111, 112, 119, 122 |
| Peas, sweet | *Lathyrus grandiflora* | 7 |
| Peony | *Paeonia* sp. | 69 |
| Peppers | *Capsicum annuum* | 7, 123 |
| Peppergrass, field | *Lepidium campestre* | 99 |
| Peppergrass, perennial, see cress, hoary | | |
| Peppergrass, Virginia | *Lepidium virginicum* | 99 |
| Persimmon | *Diospyros virginiana* | 73, 126 |
| Phlox | *Phlox* sp. | 124 |
| Phragmites | *Phragmites communis* | 40, 77, 127 |
| Pigweeds | *Amaranthus* sp. | 106, 107, 111, 116 |
| Pigweed, rough or redroot | *Amaranthus retroflexus* | 6, 8, 12, 20, 103, 104, 106, 107, 108, 110, 111, 112, 113, 115, 116, 117, 120, 121, 125 |
| Pine, Scotch | *Pinus sylvestris* | 125 |
| Pine, Austrian | *Pinus nigra* | 125 |
| Pineapple | *Annanas comosus* | 11 |
| Plantains | *Plantago* sp. | 118 |
| Poisoning, alleged, of animals by herbicides | | 28 |
| Poison ivy | *Rhus radicans* | 28, 29, 127 |
| Pond weeds | *Potomogeton* sp. | 40, 76 |
| Potato | *Solanum tuberosum* | 7, 11, 68, 76, 119, 120, 123 |
| Potato, sweet | *Ipomea batatas* | 8, 9 |
| Poverty weed | *Iva axillaris* | 56, 93 |
| Prairie cupgrass | *Eriochloa contracta* | 99 |
| President's remarks | | 1 |
| Public Law 518 | | 30 |
| Pumpkin | *Cucurbita* sp. | 8, 67 |
| Puncture vine | *Tribulus terrestris* | 16 |
| Purslane | *Portulaca oleracea* | 6, 8, 103, 104, 115, 120, 121, 122, 125 |
| Pyracantha | *Pyracantha* sp. | 7 |

# Weeds, Crops, and General Index (Continued)


| Common name | Scientific name | |
|---|---|---|
| **Q** | | |
| Quackgrass | *Agropyron repens* | 6, 12, 18, 30, 49, 82, 83, 84, 85, 113, 120, 123, 125, 128 |
| **R** | | |
| Radish | *Raphanus sativus* | 119 |
| Radish, wild | *Raphanus raphanistrum* | 30 |
| Ragweed, common | *Ambrosia artemisiifolia* | 12, 20, 107, 110, 116, 117 |
| Ragweed, bur | *Franseria tomentosa* and *discolor* | 24, 55, 92 |
| Rapeseed, Argentine | *Brassica* sp. | 96, 102, 103 |
| Raspberries | *Rubus* sp. | 123 |
| Redbud | *Cercis canadensis* | 28, 125 |
| Redtop | *Agrostis alba* | 35 |
| Registration list | | 129-137 |
| Regulatory work | | 42 |
| Research Committee, members | | 47 |
| Resolutions | | 44 |
| Right-of-way weed control | | 26, 74, 127 |
| Rocket, yellow, see cress, winter | | |
| Rose, multiflora | *Rosa multiflora* | 125 |
| Rotations, as weed control | | 96, 97, 127 |
| Rushpea, Indian | *Hoffmanseggia densiflora* | 21 |
| Rushes | *Juncus* sp. | 77 |
| Rye | *Secale cereale* | 58, 93, 99, 123 |
| Ryegrass | *Lolium* sp. | 12, 35, 112 |
| **S** | | |
| Safety in herbicide use | | 25 |
| Salpiglossis | *Salpiglossis sinuata* | 124 |
| Sassafras | *Sassafras albidum* | 28 |
| Sand sage | *Artemisia filifolia* | 73 |
| Sealing soil fumigants | | 8 |
| Sedge | *Carex riparia* | 127 |
| Shepherds purse | *Capsella bursa-pastoris* | 120, 121, 122 |
| Sideoats gramagrass | *Bouteloua curtipendula* | 99 |
| Skunkbrush | *Rhus trilobata* | 73 |
| Smartweed, ladysthumb | *Polygonum persicaria* | 98, 116, 117 |
| Smartweed, Pennsylvania | *Polygonum pennsylvanicum* | 20, 102, 107 |
| Smartweed, swamp | *Polygonum coccineum* | 24, 57 |
| Smartweed, water | *Polygonum* sp. | 76 |
| Smartweeds | *Polygonum* sp. | 106, 107, 115, 116, 121, 122, 127 |
| Solomon's seal, starflowered false | *Smilicina stellata* | 116 |
| Sorghum | *Sorgum* sp. | 11, 13, 16, 19, 23, 59, 76, 105, 106, 108, 127 |
| Sowthistle, perennial | *Sonchus arvensis* | 29, 54, 91, 110, 120 |
| Soybean | *Glycine max* | 5, 11, 20, 23, 62, 76, 104, 109, 110, 111, 127 |
| Speedwells | *Veronica* sp. | 39 |
| Spinach | *Spinacia oleracae* var. *inermis* | 7, 67 |
| Spruce | *Picea* sp. | 85, 125, 126 |
| Spurge, prostrate | *Euphorbia supina* | 39 |
| Spurge, leafy | *Euphorbia esula* | 16, 17, 24, 29, 50, 85 to 88 |
| Spurry, corn | *Spergula arvensis* | 100 |
| Squash | *Cucurbita* sp. | 8, 67 |
| Stinkgrass | *Eragrostis cilianencis* | 16, 20, 99, 114 |
| Stinkweed | *Thlaspi arvense* | 15, 30, 96, 103, 104, 110, 111, 115 |
| Strawberry | *Fragaria* sp. | 7, 8, 11, 70, 123 |
| Stubble cover—effect on germination of wild oats | | 101 |
| Sudangrass | *Sorgum vulgare* | 76 |
| Sumac | *Rhus glabra* | 73 |
| Summerfallow, chemical | | 16, 104 |
| Sunflower | *Helianthus* sp. | 30, 97 |
| Sweetclover | *Melilotus* sp. | 15, 63, 75, 113, 114, 115 |
| Switchgrass | *Panicum virgatum* | 76, 99 |
| **T** | | |
| Tansy | *Tanacetum vulgare* | 30 |
| Tanweed, see swamp smartweed. | | |
| Thistle, Canada | *Cirsium arvense* | 6, 24, 29, 54, 90, 91, 120, 121 |
| Thistle, musk or nodding | *Carduus nutans* | 21 |
| Thistle, Russian | *Salsola kali* | 16, 96, 103, 104, 109 |
| Tillage (for weed control), see cultivation. | | |
| Toadflax, yellow | *Linaria vulgaris* | 56, 92, 93 |
| Tobacco | *Nicotiana tabacum* | 9, 11, 124, 125 |
| Tomato | *Lycopersicum esculentum* | 7, 8, 67, 119, 120, 123, 128 |
| Trefoil, birdsfoot | *Lotus corniculatus* | 8, 19, 113, 114, 115 |
| Trees—killing | | 72, 73 |
| Tulips | *Tulipa* sp. | 7, 69 |
| Turf weed control | | 35, 36, 37, 38, 66, 118, 119 |
| Turnip | *Brassica campestris* var. *rapa* | 117, 128 |
| **V** | | |
| Velvet leaf | *Abutilon theophrasti* | 12, 30, 117 |
| Vetch, crown | *Coronilla varia* | 116 |
| Volatility, herbicide, damage from | | 25 |
| **W** | | |
| Weed, water | *Elodea* sp. | 76 |
| Wheat | *Triticum vulgare* | 16, 20, 57, 58, 76, 96, 97, 98, 99, 100, 101, 102, 103, 105, 113, 124, 125, 127 |
| Wheatgrass, crested | *Agropyron cristatum* | 115, 125 |
| Wheatgrass, intermediate | *Agropyron intermedium* | 115 |
| Wheatgrass, western | *Agropyron smithii* | 24 |
| Witchgrass | *Panicum capillare* | 16, 20, 35 |
| Wild-rye, Russian | *Elymus junceus* | 115 |
| Woody plant control | | 28, 73, 74, 124, 125, 126 |
| **Y** | | |
| Yew | *Taxus* sp. | 6, 7, 71 |
| **Z** | | |
| Zinnia | *Zinnia elegans* | 124 |
| Zoysia | *Zoysia* sp. | 35 |




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# Herbicide List and Index

The nomenclature of this list is based so far as possible on the Report of the Terminology Committee of the Weed Society of America, in Weeds, 6:73, Jan., 1958. The "Research Summaries" have not been indexed for herbicides, since most of them are mentioned on each page.

Names which begin with numerals are indexed as if spelled out: capitalization is indicated.


**A**

Alanap 1—NPA
Alanap 3—sodium salt of NPA
allyl alcohol ..... 8
AMA—octyl-dodecyl ammonium methyl arsonate ..... 37, 119
Amino triazole—amitrol
amitrol—3-amino-1,2,4-triazole ..... 5, 6, 16, 40, 83, 84, 85, 86, 91, 93, 94, 97, 102, 104, 106, 107, 112, 120, 121, 124, 125, 126, 127
Amoben—trademark for 3-amino-2,5-dichlorobenzoic acid
AMS—ammonium sulfamate ..... 86, 87, 89, 125
ATA—amitrol
Atlacide—trademark for a mixture containing 60% sodium chlorate ..... 97
Atrazine—trademark for G-30027

**B**

Baron—trademark for erbon
BDM—borate-2,4-D mixture ..... 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 116
Bioquin—copper 8-quinolinolate ..... 39
BMM—borate-monuron mixture ..... 87, 88, 89, 92, 93, 94, 95
borax—$Na_2B_4O_7$—$10H_2O$ ..... 21, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 116

**C**

calcium arsenate ..... 35, 36
CBMM—chlorate-borate-monuron mixture ..... 87, 89, 92
CBM—chlorate-borate mixture ..... 87, 88, 89, 95
CDAA—2-chloro-*N*,*N*-diallylacetamide ..... 11, 23, 35, 39, 96, 101, 102, 104, 106, 107, 108, 110, 111, 114, 116, 117, 118, 120, 121, 122, 123, 124, 125
CDEC—2-chloroallyl diethyldithiocarbamate ..... 39, 117, 123
CDT—2-chloro-4,6-bis(diethylamino)-*s*-triazine ..... 10, 102, 106, 110, 111
C-56—code for hexachlorocyclopentadiene ..... 82, 83
Chlorazine—trademark for CDT
chlordane—1,2,4,5,6,7,8,8-octachloro-4,7-methano-3a,4,7,7a-tetradhydroindane ..... 35, 119
Chlorea—trademark for a CBMM
chloropicrin ..... 8
CIPC—isopropyl *N*-(3-chlorophenyl)carbamate ..... 6, 40, 101, 102, 110, 115, 117, 118, 120, 121, 122, 124
CMU—monuron
CP1815—See Fisons 1815
CP6936—code for 2-chloro-*N*-ethyl-*N*-phenylacetamide
Concentrated BORASCU—trademark for granular anhydrous borax
copper sulfate ..... 39
Crag Herbicide 1—code for sesone
Cyanamid—trademark for calcium cyanamide ..... 101
dalapon—2,2-dichloropropionic acid ..... 4, 7, 16, 18, 20, 28, 82, 83, 84, 94, 99, 102, 109, 111, 112, 113, 114, 115, 117, 118, 119, 120, 123, 125, 126

**D**

DB Granular—trademark for a BDM
DCU—dichloral urea ..... 102, 110, 117
Diax—trade name, mixture 2,4-D and citric acid ..... 102, 103
Dichlone—trademark for phygon
Dinoben—trademark for 2,5-dichloro-3-nitrobenzoic acid
diuron—3-(3,4-dichlorophenyl)-1,1-dimethylurea ..... 87, 92, 99, 100, 102, 106, 107, 124, 125
DMA—disodium monomethylarsonate ..... 37, 38, 116, 119
DMTT—3,5-dimethyltetrahydro-1,3-5,2H thiadiazine-2-thione (Mylone) ..... 7, 122, 124
DNBP—4,6-dinitro-*o*-*sec*-butylphenol ..... 37, 38, 39, 99, 106, 107, 110, 111, 112, 113, 119, 120, 121, 123
DSMA—DMA

# Herbicide List and Index (Continued)


**E**

endothal—3,6-endoxohexahydrophthalic acid ..... 38, 39, 117, 118
EPTC—ethyl-*N*-*N*-di-*n*-propylthiolcarbamate ..... 11, 15, 23, 39, 82, 93, 96, 97, 99, 100, 101, 102, 103, 104, 106, 107, 108, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 123, 124, 125
erbon—2-(2,4,5-trichlorophenoxy)ethyl 2,2-dichloropropionate ..... 20, 36, 49, 82, 86, 87, 88, 89, 90, 91, 93, 95
EXD—ethyl xanthogen disulfide ..... 38
FB-2—code for 1:1'-ethylene-2:2'-bipyridinium dibromide ..... 84, 91, 98, 99, 103, 104, 118

**F**

fenuron—3-phenyl-1,1-dimethylurea ..... 20, 21, 83, 84, 87, 90, 95
Fisons 1815—code for mixture chlorinated benzoic and cresoxyacetic acids ..... 88, 95, 97, 99, 102, 103, 104, 107, 120
4-chloro-2-butynyl *N*-3-chlorophenyl)carbamate (S-847) ..... 84, 97, 98, 100, 102
4-(MCPB)—4-(2-methyl-4-chlorophenoxy)butyric acid ..... 15, 90, 91, 96, 99, 100, 103, 104, 106, 107, 111, 112, 113, 114, 115, 119, 128
4-(2,4-DB)—4-(2,4-dichlorophenoxy)butyric acid ..... 14, 15, 19, 90, 91, 93, 99, 100, 103, 104, 106, 107, 108, 110, 111, 112, 113, 114, 115, 116, 128

**G**

GA—gibberellic acid
G-25804—code for CDT; Chlorazine; Geigy 444E
G-27682—code for simazin
G-27901—code for 2-chloro-4-ethylamino-6-diethylamino-*s*-triazine (Trietazine) ..... 10, 39, 106, 107, 108, 111, 112, 120, 121, 122, 124, 125
G-30026—code for 2-chloro-4-isopropylamino-6-methylamino-*s*-triazine ..... 91, 100, 120
G-30027—code for 2-chloro-4-isopropylamino-6-ethylamino-*s*-triazine (Atrazine) ..... 10, 39, 100, 107, 120
G-30028—code for 2-chloro-4,6-bis(isopropylamino)-*s*-triazine (Propazine) ..... 10, 39
G-30031—code for 2-chloro-4-diethylamino-6-isopropylamino-*s*-triazine ..... 10, 39, 106, 107, 111, 112, 123
G-30044—code for 2-methoxy-4,6-bis(ethylamino)-*s*-triazine ..... 39, 106
G-30451—code for 2-chloro-4-*n*-propylamino-6-isopropylamino-*s*-triazine ..... 39
G-31435—code for 2-methoxy-4,6-bis(isopropylamino)-*s*-triazine (Methoxy Propazine) ..... 10, 82

**H**

HCA—hexachloroacetone ..... 82, 83, 103, 107, 123

**I**

IPC—isopropyl-*N*-phenylcarbamate ..... 96, 102, 118
IAA—indoleacetic acid ..... 2

**K**

Karmex DW—trademark for diuron
Karmex W—trademark for monuron
KOCN—potassium cyanate ..... 37, 116
Kuron—trademark for erbon

**L**

lead arsenate ..... 35, 36, 119

**M**

MAA—monomethylarsonic acid ..... 37
magnesium chlorate ..... 127
MCP—MCPA
MCPA—2-methyl-4-chlorophenoxyacetic acid ..... 38, 89, 90, 91, 92, 94, 100, 103, 104, 107, 109, 111, 112, 113, 114, 115
methyl bromide ..... 7, 8
MH—maleic hydrazide ..... 16, 37, 93, 96
MCPP—2-(MCPP)
monuron—3(*p*-chlorophenyl)-1,1-dimethylurea ..... 6, 16, 20, 21, 83, 87, 89, 90, 92, 95, 97, 99, 100, 106, 115, 120, 121, 122, 124, 125, 128
Mylone—trademark for DMTT

**N**

neburon—1-*n*-butyl-3-(3,4-dichlorophenyl)-1-methylurea ..... 7, 9, 13, 15, 36, 38, 96, 98, 99, 100, 103, 106, 107, 109, 114, 118, 119, 123, 124
Novon—trademark for erbon
NPA—*N*-1-naphthylphthlamic acid ..... 6, 9, 36, 110, 111, 119, 123, 124
*N*-(2,6-dimethylphenyl)alpha-chloroacetamide (M-625) ..... 100, 102




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**O**

ONCB—code for orthonitrochlorobenzene ..... 88
1,2,4,5-tetrachlorobenzene ..... 96, 97, 98, 101, 103, 104

**P**

PAX—trademark for crabgrass killer ..... 36
PBA—mixtures of chlorinated benzoic acids ranging from dichloro- to pentochloro- ..... 13, 19, 20, 21, 24, 86, 88, 89, 90, 91, 92, 99, 116
PCP, sodium salt—sodium pentachlorophenate ..... 106, 111
phygon—2,3-dichloro-1,4-naphthoquinone ..... 39, 40
Polybor-chlorate—trademark for a CBM
polychlorobenzoic acids—PBA
*P,P*-dibutyl-*N,N*-diisopropylphosphinic amide ..... 36
Propazine—trademark for G-30028

**R**

Randox—trademark for CDAA

**S**

Sesin—trademark for sesone
sesone—sodium 2,4-dichlorophenoxyethyl sulphate ..... 6, 7, 36, 124, 125
silvex—2-(2,4,5-trichlorophenoxy)propionic acid ..... 20, 38, 40, 85, 89, 90, 91, 95, 118, 126, 128
simazin—2-chloro-4,6-bis(ethylamino)-*s*-triazine ..... 4, 6, 7, 10, 12, 23, 82, 83, 85, 88, 89, 91, 93, 99, 100, 101, 102, 103, 104, 106, 107, 110, 115, 118, 119, 120, 121, 122, 123, 124, 125, 128
SMDC—sodium methyldithiocarbamate (Vapam) ..... 7, 8, 119, 122, 124
sodium arsenite ..... 38, 40, 98, 99, 118
sodium chlorate ..... 21, 87, 88, 89, 90, 91, 92, 95
Stoddard Solvent—petroleum product containing 15 to 18 percent of aromatic compounds ..... 38, 121

**T**

TBA—2,3,6-TBA
TCA—trichloroacetic acid ..... 37, 84, 96, 99, 101, 102, 109, 111, 114, 115, 116, 117, 118, 120, 121, 123, 125
TCB—trichlorobenzene ..... 40
Telone—trademark for 1,3-dichloropropene ..... 8
Telvar DW—trademark for diuron
Telvar W—trademark for monuron
tetrazole derivatives ..... 2
3-amino-2,5-dichlorobenzoic acid (Amoben) (ACP-M-629) ..... 12, 110
3-(3,4-dichlorophenyl)-1,1-diethylurea ..... 88, 91, 98, 99, 100, 103, 111
3Y9—tris-(2,4-dichlorophenoxyethyl) phosphite ..... 9, 101, 102, 104, 106, 108, 120
Trietazine—trademark for G-27901
2-chloro-*N*-ethyl-*N*-phenylacetamide (CP6936) ..... 107, 110, 111, 116, 117, 120, 121, 122
2,5-dichloro-3-nitrobenzoic acid ..... 8, 12, 107, 110, 111, 120
2,4-D—2,4-dichlorophenoxyacetic acid ..... 3, 11, 15, 16, 17, 19, 21, 22, 24, 25, 28, 36, 38, 40, 85, 86, 87, 89, 90, 91, 92, 94, 95, 97, 98, 99, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 118, 119, 120, 121, 128
2,4-DB—4-(2,4-DB)
2,4-DES—sesone
2,4-D—2,4,5-T mixtures ..... 94, 95, 116, 128
2,4,5-T—2,4,5-trichlorophenoxyacetic acid ..... 24, 28, 36, 38, 92, 94, 95, 103, 125, 126, 128
2,3,6-trichlorophenylacetic acid ..... 21, 90
2,3,6-TBA—2,3,6-trichlorobenzoic acid (See also PBA) ..... 13, 19, 21, 24, 36, 85, 86, 88, 91, 92, 93, 94, 96, 102, 103, 104, 106, 107, 109, 116, 120, 126
2-(MCPP)—2-(2-methyl-4-chlorophenoxy)propionic acid ..... 91, 100
2-(2,4,5-TP)—silvex

**U**

Ureabor—trademark for a BMM
Urox—trademark for 3-(p-chlorophenyl)-1,1-dimethylurea trichloroacetate ..... 40

**V**

Vapam—trademark for SMDC

**Z**

Zytron—mixture, 20% silvex, 80% dalapon ..... 104, 126




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